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Edutainment Technologies

Educational Games and Virtual Reality/ Augmented Reality Applications

6th International Conference on E-learning and Games, Edutainment 2011
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Preface

The new subject area "edutainment" has been widely employed and explored in research, industry and learning. Experts around the world have made an effort to promote "edutainment", which is the integration of education and entertainment. With the help of advanced technologies - mobile devices, computers, software, games and augmented/virtual Reality applications – edutainment has been quickly accepted by the public as an effective way of learning.

The 6th International Conference on E-Learning and Games (Edutainment 2011) was held in Taipei, Taiwan during September 7–9, 2011. The first conference in the series was Edutainment 2006, held in Hangzhou, China. Following the success of the first event, Edutainment 2007 was held in Hong Kong, China, Edutainment 2008 in Nanjing, China, Edutainment 2009 in Canada, and Edutainment 2010 in Changchun, China.

The main purpose of the Edutainment conferences is to provide an outstanding forum for participants to exchange results and present the-state-of-the-art in research and practice of edutainment. The conference covers pedagogical principles as well as design and technological issues related to edutainment. From the pedagogical viewpoint, multi-touch systems, computer graphics, multimedia and augmented/virtual reality applications may offer a new angle on design for learning. Technologically, education and entertainment employ advanced computing, multimedia and Internet technology along with embedded chips and sensors that are used with wireless, mobile and ergonomic technology.

This year, we received around 130 submissions from 15 different countries and regions including Canada, China, Germany, Japan, Korea, Singapore, The Netherlands, Taiwan, UK, USA and Vietnam. A total of 42 full papers were selected after peer review for this volume. Six related workshops were also held jointly: Game-Assisted Language Learning, Learning with Robots and Robotics Education, e-Portfolio and ICT-Enhanced Learning, Game-Based Testing and Assessment, Trends, Development and Learning Processes of Educational Mini Games, and VR and Edutainment.

We are grateful to the Program Committee for their great efforts and hard work to get all the papers reviewed in a short period of time. We are grateful to the Organizing Committee for their support of this event. We would also like to show our great appreciation to the attendees who came from all over the world since, without their enthusiastic participation and significant contributions, Edutainment 2011 would not have been such a success.

The financial support from many governmental agencies and research organizations in Taiwan also contributed to the success of the conference. They all deserve our sincere gratitude for the time and energy they devoted to making Edutainment 2011 a technically and pedagogically worthwhile and enjoyable event for all participants.

September 2011

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VR and Edutainment

Hybrid Document Matching Method for Page Identification of Digilog Books

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Abstract. *Digilog Books* are AR (Augmented Reality) books, which provide additional information by visual, haptic, auditory, and olfactory senses. In this paper, we propose an accurate and adaptive feature matching method based on a page layout for the *Digilog Books*. While previous *Digilog Books* attached visual markers or matched natural features extracted from illustrations for page identification, the proposed method divides input images, captured by camera, into text and illustration regions using CRLA (Constrained Run Length Algorithm) according to the page layouts. We apply LLAH (Locally Likely Arrangement Hashing) and *FAST+SURF* (FAST features using SURF descriptor) algorithm to appropriate region in order to get a high matching rate. In addition, it merges matching results from both areas using page layout in order to cover large area. In our experiments, the proposed method showed similar matching performance with LLAH in text documents and *FAST+SURF* in illustrations. Especially, the proposed method showed 15% higher matching rate than LLAH and *FAST+SURF* in the case of documents that contain both text and illustration. We expect that the proposed method would be applicable to identifying various documents for diverse applications such as augmented reality and digital library.

Keywords: Document matching, augmented reality, Digilog Book, page identification.

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The Development of the AR-Fitness System in Education

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Abstract. The use of information technology (IT) in education has been known for nearly half a century and is well known for creating a wide range of learning opportunities. Augmented reality (AR) has been recognized as an advance technology allowing learners to interact with both virtual and real worlds, while at the same time bringing in potential enhancements to the learning process. In addition to the effect of AR on learning, many recent studies have reported the fruitful outcomes of AR applications in healthcare. Combining these two essential merits by the use of AR technology, this research aims to develop an AR system which would allow learners to benefit from both cognitive learning and the effective fitness exercises. We develop a prototype AR system consisting of four types of effective fitness exercises in conjunction with five categories of Physical Education knowledge.

Keywords: Augmented reality, Technology-enhanced learning, Edutainment, Fitness.

1 Introduction

The use of VR and AR has potential to motivate as well as engage the learners as they can explore the teaching materials to differentiate between the real and virtual objects; meanwhile Kaufmann [1] also claims that AR is a variation of virtual reality (VR). Heim [2] reports that the VR can provide powerful and unique information based educational experiences. In a case study Rountree, Wong, & Hannah [3] investigated the effectiveness of using virtual artifacts in teaching classic arts to the first-year university students. The work shows that use of virtual images provide advantageous mediated focus and prove to be useful effective tools in supporting visual literacy. The learning environment provides learners with more interactions, i.e. the virtual objects and the virtual learner's image in the virtual world, the learner, and the real objects in the real world [4]. As use of information technology (IT) in education has been known for nearly half a century and is well known for creating a wide range of learning opportunities, some researchers report that VR as an implementation of this concept has been recognized as an advance technology allowing learners to use IT to interact with both virtual and real worlds at the same time bringing in potential enhancements to the learning process [5].

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Relating to the concept of VR and AR, Kaufmann [1] pointed out that VR technology immerses the user inside a complete virtual environment. In contrast, AR allows a user to see the real world and combine it with virtual objects. This enhances AR with the power of reality, rather than replacing it. Here a user can realize how the virtual and real objects coexist at the same time. More recently researchers shown that better results can be achieved when dividing the virtual environment into specific groups of VR, mixed reality (MR) and augmented reality (AR) [6-7].

In addition to the use of technology to enhance learning, many recent researches reported that AR and VR can also be effectively used in the healthcare. Regarding to the physical health, Lamounier et al [8] proposed using the Augmented Reality techniques to visualize and effectively interpret the cardiologic signs. This may facilitate a better understanding of the information reflected by patients. In terms of psychological healthcare applications, researchers [9] reported that therapeutic recreation specialists should use the VR environment shared with the patients and allow them to virtually preview the sites that they may want to personally tour later. This process of leisurely education can build up the necessary confidence for the clients and may lead to greater independence once they are integrated back into the society.

Combining these two essential merits, healthcare and education, by the use of AR technology, the same AR research team proposes a new learning model 'exercising while learning' [10]. Our previous studies of the use of AR in English learning and in Science learning were conducted in primary eight to nine year old pupils [11] and in fourteen year old high school students [12] respectively. The results from both experiments of using AR learning systems in different subjects revealed significantly better academic performance and learning attitude toward the subjects than the control group with the use of the traditional teaching approaches of textbooks and traditional keyboard-mouse computer assisted instruction (KMCAI).

In spite of the higher academic performance and more positive learning attitude in conjunction with extra physical activities while doing their learning at the same time [13], there is still a demand for improving the effectiveness of the exercises in the AR learning system as most recent researches of using AR or VR in learning only focused on the interactions between the virtual and real world [14], the interactions between the learners and the AR or VR systems [15] and some extra body movements in any free styles [16] without the deliberate design of those physical activities. Therefore, based on empirical evaluations of thousands of users, including both teachers and students in primary and high school education, this study intends to develop an AR learning system with standardized training of fitness exercise. When students do learning within the use of this AR system, they obtain the effective fitness exercise training at the same time.

The aims of this study are to: (1) design the effective fitness exercises for the AR system including four types of fitness exercises: 'Stair Stepping' (AR-Stepping), 'Inverse Jumping' (AR-Jumping), 'Sit-Ups' (AR-SitUps) and Bending (AR-Banding), are corresponding to the four types of exercises: 'Cardiorespiratory Endurance', 'Muscular Strength', 'Muscular Endurance' and 'Flexibility' respectively; (2) develop the cognitive knowledge content for the AR system including five categories of PE knowledge: Cardiopulmonary Endurance, Flexibility, Explosiveness, Muscular Endurance and Sport Injury; (3) and integrate the above two functions, the effective fitness exercises and cognitive learning activities, into the AR system.

The rest of the paper is organized as follows. The design of the types of the effective AR-Fitness exercises is presented in Section 2 followed by the technical settings in conjunction with the conceptual design of the AR prototype in Section 3. Section 4 presents the implementation designs of the four effective AR-Fitness exercises which is followed by a preliminary evaluation of the system in Section 5 before the summary and future works in the final Section 6.

2 Types of the Effective Fitness Exercises in AR-Fitness

The physical fitness contains five physical indicators: 'BMI' (Body Composition), 'Cardio-respiratory Endurance', 'Muscular Strength', 'Muscular Endurance', and 'Flexibility'. Among these five indicators, the BMI is calculated by formulas as below (Metric BMI Formula):

$$BMI=W/L^2\ (kg/m^2) \tag{1}$$

where W is weight in kilograms; and L is the height in meters.

The other four indicators are measured by four types of exercises which can be categorized into three kinds of fitness: Cardio-respiratory Endurance is categorized in Aerobic Fitness; both Muscular Strength & Endurance are in Muscular Fitness; and Flexibility is in Flexibility Fitness

In terms of exercise types, traditionally walking, running and biking are categorized to Cardio-respiratory Endurance; weight training and circle training are categorized to Muscular Strength; sit-ups, push-ups and pull-ups are categorized to Muscular Endurance; and extension, yoga and Pilates are categorized to Flexibility respectively.

Further, in Taiwan physical education, there are some certain appointed tests applied to the corresponding types of exercises in order to measure the certain types of physical fitness. For instance, 3minutes Stair Stepping is used to the measurement of the indicator of Cardio-respiratory Endurance; Standing Broad Jump is to Muscular Strength; one minute Sit-Ups is to Muscular Endurance; and Sit-and-Reach is to Flexibility. For the BMI indicator, body weight control is usually applied.

In the AR-Fitness system, four subsystems are developed to train students' physical fitness while learning. The four subsystems in the AR-Fitness, 'Stair Stepping' (AR-Stepping), 'Inverse Jumping' (AR-Jumping), 'Sit-Ups' (AR-SitUps) and Bending (AR-Banding), are corresponding to the four types of exercises: 'Cardio-respiratory Endurance', 'Muscular Strength', 'Muscular Endurance' and 'Flexibility' respectively.

3 Technical Settings

In order to combine the two essential functions, healthcare and education, by the use of AR technology, this study proposed a new learning model 'exercising while learning' [10] and develop an AR learning system with standardized training of physical fitness, called AR-Fitness. When students do learning within the use of the AR-Fitness system, they obtain the effective fitness exercise at the same time. The significant strength of applying this AR-Fitness system is to enhance students' learning in conjunction with increasing students' physical exercise particularly when students are short of physical exercise but school has a limited time schedule [13].

The approach to the implementation of AR-Fitness in the educational environment is taken by creating an AR learning system, using the current teaching curriculum, e.g. the cognitive Physical Education (PE) knowledge, together with physical fitness activities. This system is to combine learning with four types of fitness exercises: 'Stair Stepping' (Cardiorespiratory Endurance), 'Inverse Jumping' (Muscular Strength), 'Sit-Ups' (Muscular Endurance) and Bending (Flexibility), which are corresponding to the names of the subsystems in AR-Fitness as AR-Stepping, AR-Jumping, AR-SitUps, and AR-Bending respectively.

3.1 Setup of AR-Fitness

When the AR-Fitness system is applied in the classrooms, students need not wear a head-mounted display or other expensive equipment since more school classrooms in Taiwan are equipped with at least one computer and a projector with a screen. Thus, a common webcam is the only extra equipment for using the AR-Fitness system. The webcam is placed in front of the students in order to capture students' gestures and body movement to interact with the AR system. Students have to wear the 'red glove' as the marker which is used to activate the sense area in the system. Students have to do body movement in order to hit the correct answers up to some certain number of times instead of only hitting once. The webcam will capture students' gestures and body movement to interact with the system.

Hardware of the AR-Fitness System. The aim of the AR-fitness is to evaluate the possibility of adding body gesture to learning environment by utilizing the existing hardware infrastructure in the elementary school. Table 1 lists the hardware used in the AR-fitness system**.**

Development of the Controlling System. The controlling system firmware is coded by Open CV and Dev C++, while the PC operation system must be Windows 2000/XP or above versions. A popular Flash Player can play the media files to execute the AR-fitness course.

Table 1. AR-Fitness Hardware Requirements

Item	Specification
WebCam	Static image resolution: 1280 x 960 pixels Dynamic video: GIF format, 30 frames/sec
Projector	FUJITSU LPF-4801 equivalent performance Projection capability: 200cm(H)x120cm(W)
Computer	CPU:1.60GHz, DRAM:Minimum:512M
Screen Size, Tripod	180cm(H)x180cm(W), ≧ 115cm
RGB-Connector/Cable	Standard VGA cable to connect PC and projector

4 The Conceptual Design of the AR-Fitness System

The AR-Fitness system starts from 'Flash Animation (Test Start)' which is used to attract students' attention by some new technology novelty of audio and visual effects. The AR-Fitness system consists of four types of AR-fitness exercises: S (*Stepping*);

F (*Flexibility*); J *(Jumping*); SU (*Sit-Ups*) and five PE knowledge: CE (*Cardiopulmonary Endurance*); F (*Flexibility*); E (*Explosiveness*); ME (*Muscular Endurance*); SI (*Sport Injury*) while n = the number of the times for users to touch the sensor area.

After the animation, the learners have to choose one of the four types of fitness exercises, 'Stair Stepping' (AR-Stepping), 'Inverse Jumping' (AR-Jumping), 'Sit-Ups' (AR-SitUps) and Bending (AR-Banding) from the 'Main Menu' (Fig. 1).

Alternatively they can also directly go for 'Quizzes' (Figure 2) without exercise. Five different PE knowledge topics are available in conjunction with fitness options including Cardiopulmonary Endurance, Flexibility, Explosiveness, Muscular Endurance and Sport Injury.

To ensure the strength of exercising is measurable, a certain number of questions are pre-determined by the teacher. Two criteria, answering the pop-up question and a designed effective number of exercises, must be met to pass the quiz. An independent timer is added to the system to limit learner's response time for a better competing effect.

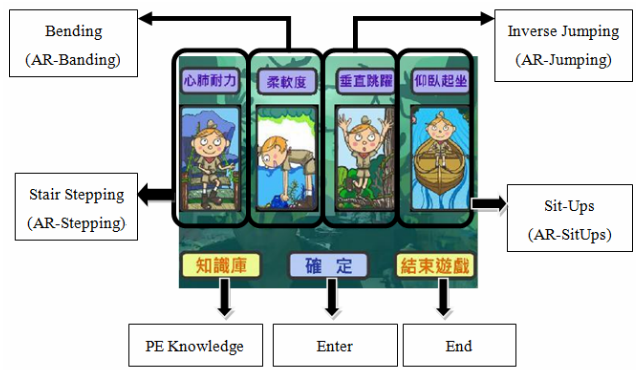

Fig. 1. Main menu with the four types of fitness exercises

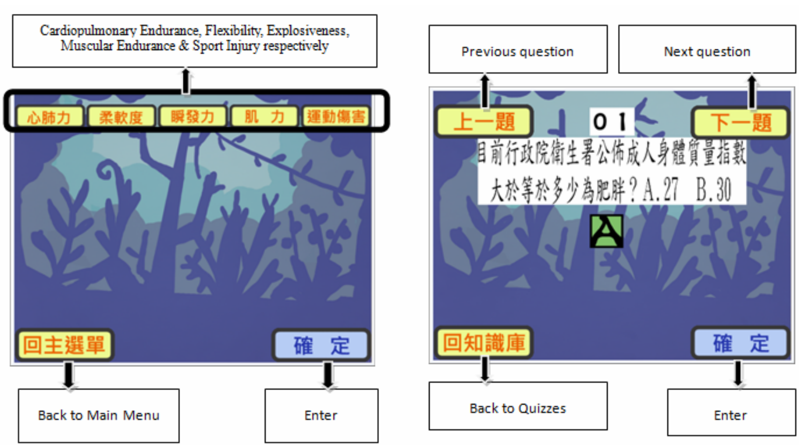

Fig. 2. Quizzes including Cardiopulmonary Endurance, Flexibility, Explosiveness, Muscular Endurance and Sport Injury

5 The Implementation Designs of the Four Effective AR-Fitness Exercises

In order to assure the effectiveness of the AR-Fitness exercises, all four type exercises are deliberately designed by the fitness specialist. The operations of the four effective AR-Fitness exercises are described as below.

To have a whole picture of the interactions between AR-Fitness and the learner, the four subsystems of AR-Stepping, AR-Jumping, AR-SitUps, and AR-Bending were be introduced in details.

Stepping**:** When students do ‘Stair Stepping’ within the system of AR-Fitness, firstly they have to align their feet with the ruler on the fixed location corresponding to their own heights. Markers are worn on their hands and knees. In AR-Fitness Stepping, students have to read the cognitive question in 20 seconds and then use their ‘hand marker’ to choose the correct answer by using their virtual images to touch the sense area in the virtual AR-Fitness system. After choosing the answer, the timer in the system will be activated and students have to start doing stepping and their knees must be raised high enough to make sure the ‘knee marker’ reach another sense area for their knees up to 60 times in 36 seconds. In this system, the audio metronome is provided for students to follow the fixed beat (100 steps per minute) easily. Further, in order to reach the effective training for cardiopulmonary endurance, each student has to answer five questions in a round.

Jumping**:** After students align their feet with the ruler on the fixed location corresponding to their own heights while doing ‘Inverse Jumping’, in differentiating from the other three exercises, they have to choose the gender as the system provides different criterion of tempos and heights for different genders. Markers are worn on their hands and head. In AR-Fitness Jumping, students also have 20 seconds for reading a cognitive question and then use their ‘hand marker’ to choose the correct answer by using their virtual images to touch the sense area in the virtual AR-Fitness system. After choosing the answer, the timer in the system will be activated and students start jumping. They have to jump high enough to use their ‘head marker’ to touch another sense area as a target for height up to 5 times in 30 seconds. To assure the effectiveness of Muscle Strength training, each student has to answer five questions in a round.

Sit-Ups**:** When students do ‘Sit-Ups’ within the system of AR-Fitness, they have to sit on the sport mat on the specific location according to their heights. Markers are placed on their hands and head. In AR-Fitness Sit-Ups, there are 20 seconds for students to read the cognitive question and then use their ‘hand marker’ to choose the correct answer by using their virtual images to touch the sense area in the virtual AR-Fitness system. After choosing the answer, the timer in the system will be activated. When students do Sit-Ups, they have to lie down on the sport mat, bend their knees (for the reason of protecting their spin), cross their hands in front of the chest. Meanwhile, to make sure the correct position for standardized Sit-Ups, another student in the same group has to sit on the playing students’ feet to avoid any incorrect foot movement. When they sit up, their ‘head marker’ has to touch the sense area by using their virtual images to touch the sense area in the virtual AR-Fitness system.

The criterion for the effective exercise training is 7 Sit-Ups in 30 seconds and each student has to answer five questions in a round.

Bending**:** When students do ‘Bending’ within the system of AR-Fitness, they will be asked to stand on the mat which is aligned with the ruler on the certain location according to their heights. Meanwhile, markers are worn on their hands and knees. The features of this exercise are students have to use their hand-markers to touch the ‘hand sense area’ but there is another sense area, ‘knee sense area’, which is used for checking if students’ keens stand upright while bending. That is, if students’ knees bend, the effectiveness of their waist bending will be diminished. In AR-Fitness bending, students also have 20 seconds for reading a cognitive question and then they have to bend their waist in order to use their ‘hand marker’ to choose the correct answer which is located on the rather low position of the screen to force students to bend up to some certain levels designed by PE specialists. Meanwhile students use their virtual images to touch the sense area in the virtual AR-Fitness system. To assure the effectiveness of Flexibility training, each student has to answer five questions in a round but each question is with different bending durations: 6, 7, 8, 9, and 10 seconds bending duration for the question number one to number five respectively.

6 A Preliminary Evaluation of the AR-Fitness System

To examine the effects of AR-Fitness in PE knowledge learning and physical fitness training, a pilot study has been implemented on the freshmen from seven classes all in different departments in a university. After four weeks within the use of the AR-Fitness system, some useful feedbacks collected by the qualitative interviews from the students in conjunction with the teachers are drawn as below.

6.1 Offer a More Interesting and Attractive Way for the Effective Fitness Training

Comparing to many other Asian countries e.g. Japan, Korea, and Mainland China, the health condition in Taiwanese adolescents is considered worse based on the indicators of BMI and Cardiopulmonary Functions [17]. Therefore, the fitness training is one of the most important courses in Physical Education (PE) in Taiwan. Based on the policy for university PE, if freshmen could pass the physical fitness test, then their second year PE modules could be exempted. In order to help students pass the test, PE teachers always do the best to encourage students to do the fitness training as frequently as possible. The traditional fitness training exercises contain walking, running and biking categorized to Cardiorespiratory Endurance; weight training and circle training categorized to Muscular Strength; sit-ups, push-ups and pull-ups categorized to Muscular Endurance; and extension, yoga and Pilates categorized to Flexibility respectively. Comparing to the traditional methods for fitness training, one teacher, (T-01) shares his experience with the use of AR-Fitness:

“The fitness training exercises in AR-Fitness are more interesting and attractive than the traditional ones as students like to these training exercises in the way of collaborations and competitions with their peers. Further, instead of only doing

some tedious training courses, doing exercises within AR-Fitness is like playing a game which would definitely raise students' interests and motivations." (Interview, Dec 2010)

Based on the qualitative interviews in this study, most students have similar views to the above interview comments seen AR-Fitness as a more interesting and attractive fitness training way than the traditional one with the new and fancy technology. Moreover, the features of collaborations and competitions in the AR-Fitness system successfully attract students' interest and trigger their motivation in the fitness training exercises.

6.2 Provide an Innovation Way for Learning by Combining Physical Exercise

Further, in addition to physical exercise, PE knowledge of the cognitive learning is also part of the compulsory course for PE. Traditionally, PE teachers use paper handouts or PowerPoint to lecture PE knowledge. However, within the use of AR-Fitness in this study, an innovation way for learning the cognitive knowledge by combing physical fitness exercises is provided. One student provides his feedback on the use of AR-Fitness:

"I think most young generations would prefer to use new technology to assist learning instead of the traditional way. I recall that when our teacher used PowerPoint to teach PE knowledge, most of us just fell into asleep in the class. Therefore, I would prefer to learn PE knowledge with the use of AR-Fitness as it is more interesting and at least keeps me moving and awake. Further, in order to pass the fitness test, I am quite happy to do the fitness training while learning PE knowledge at the same time." (Interview, Dec 2010)

Based on our qualitative interviews, the above student's feedback is in similarity to the majority of students' views that they would prefer to have body movement rather than the sedentary activity even while learning the cognitive knowledge. Further, as the physical fitness test is the compulsory students have very positive attitude to learning cognitive knowledge together with doing fitness training. AR-Fitness allows learners to be engaged in both learning and exercising concurrently.

7 Summary and Future Work

In this study, an AR-Fitness prototype system with standardized training of fitness exercise has successfully been developed. The features of the AR-Fitness system are: (1) involving the effective fitness exercises for the AR learning system including four types of fitness exercises: 'Stair Stepping' (AR-Stepping), 'Inverse Jumping' (AR-Jumping), 'Sit-Ups' (AR-SitUps) and Bending (AR-Banding); (2) containing five categories of PE knowledge: Cardiopulmonary Endurance, Flexibility, Explosiveness, Muscular Endurance and Sport Injury; and (3) finally when students do learning within the use of this AR-Fitness system, they obtain the effective fitness exercise training at the same time.

This system is expected to facilitate the combining functions of cognitive learning and effective fitness exercises. Thus, students' academic performance, learning attitude within AR-Fitness in conjunction with the system usability are going to be investigated and evaluated as the following future works.

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References

1. Kaufmann, H.: Construct3D: an augmented reality application for mathematics and geometry education. In: The Tenth ACM International Conference on Multimedia (2002)
2. Heim, M.: Virtual realism. Oxford University Press, New York (1998)
3. Rountree, J., Wong, W., Hannah, R.: Learning to look: real and virtual artifacts. Educational Technology & Society 5(1), 129–134 (2002)
4. Kerawalla, L., et al.: Making it real: exploring the potential of augmented reality for teaching primary school science. Virtual Reality 10(12), 163–174 (2006)
5. O'Brien, H.L., Toms, E.G.: Engagement as Process in Computer-Mediated Environments. Paper presented at in the ASIS&T, North Carolina, USA (2005)
6. Manzoni, G.M., et al.: New Technologies and Relaxation: An Explorative Study on Obese Patients with Emotional Eating. Journal of CyberTherapy and Rehabilitation 1(2), 11 (2008)
7. Mühlberger, A., et al.: A Virtual Reality Behavior Avoidance Test (VR-BAT) for the Assessment of Spider Phobia. Journal of CyberTherapy and Rehabilitation 1(2), 147–158 (2008)
8. Lamounier, E., et al.: On the Use of Augmented Reality Techniques in Learning and Interpretation of Cardiologic Data. In: The 32nd Annual International Conference of the IEEE EMBS, Buenos Aires, Argentina (2010)
9. Germann, C., Broida, J.K., Broida, J.M.: Using Computer-Based Virtual Tours to Assist Persons With Disabilities. Educational Technology & Society 6(3), 53–60 (2003)
10. Hsiao, K.F., Rashvand, H.F.: Body Language and Augmented Reality Learning Environment. In: The 5th IEEE/FTRA International Conference on Multimedia and Ubiquitous Engineering (MUE 2011). IEEE, Greece (2011)
11. Hsiao, K.F., et al.: Gender Differences in the Preferences toward an Educational Augmented Reality System. In: Proceedings of International Academic Conference. MCU, Taiwan (2007)
12. Hsiao, K.F.: Can We Combine Learning with Augmented Reality Physical Activity? Journal of CyberTherapy and Rehabilitation 3(1), 51–62 (2010)
13. Hsiao, K.F., Chen, N.S., Huang, S.Y.: Learning while Exercising for Science Education in Augmented Reality among Adolescents. Interactive Learning Environments (2010), `http://dx.doi.org/10.1080/10494820.10492010.10486682`
14. Huang, H.-M., Rauch, U., Liaw, S.S.: Investigating learners' attitudes toward virtual reality learning environments: Based on a constructivist approach. Computers & Education 55(3), 1171–1182 (2010)

15. Chang, C.W., et al.: Improving the authentic learning experience by integrating robots into the mixed-reality environment. Computers & Education 55(4), 1572–1578 (2010)
16. Yang, J.C., Chen, C.H., Jeng, M.C.: Integrating video-capture virtual reality technology into a physically interactive learning environment for English learning. Computers & Education 55(3), 1346–1356 (2010)
17. Ministry of Education Division of Physical Education, The plan of 'Happy Life' in high schools (2007), `http://www.edu.tw/EDU_WEB/Web/publicFun/tmpurl.php?sid=18906&fileid=158077&open` (retrieved on February 18, 2011)

ARMate: An Interactive AR Character Responding to Real Objects*

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Abstract. In the research field of augmented reality (AR), applications using interactive characters have been developed as the form of giving users information such as LEGO assembly guidance and explanation about historical artifacts. Even though these characters respond to interaction with users, they could not create substantial effects or changes in a real space. Therefore, this limitation makes users reduce their coexistence with the AR characters. In this paper, we present an interactive AR character that directly interacts with real objects. The interactive AR character automatically determines how to behave and to control these objects. At first, we make working space populated by AR characters that has a real object with which the AR character can interact. As an interactive AR character, we implement ARMate, which presents realistic responses according to changes of real objects manipulated by a user in real time. We develop ToyCart as a physical object that includes hardware devices for movement, and ARMate can control ToyCart. Finally, we expect that our AR character can increase coexistence through real object-based interaction.

Keywords: Augmented reality, intelligent agent, interactive character.

1 Introduction

Many researchers have developed various applications including interactive characters in augmented reality settings, with the majority of these applications developed for education (e.g., *Interior Design* [1], *Assembly Guidance* [2], *Cooking Navigation* [3], *Art History Application* [4]) and for entertainment (e.g., *MonkeyBridge* [5] and *EyePet* [Sony Computer Entertainment Europe]). To offer information suitable for a user's interaction, AR characters properly respond to the user by using gestures, virtual objects, text, images, and sound. For example, a virtual character in *Cooking Navigation* performs helpful actions suitable to a user's behavior. Autonomous characters in *MonkeyBridge* jump up or down along the path made by the user. A virtual pet in *EyePet* moves along a virtual car controlled by the user.

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Even though these characters respond to interaction with users, they could not have substantial effects on changes in a real space. Thus, this limitation makes users reduce their coexistence with the characters. The AR character *Kobito* [6] can control a real object and it can make substantial effect on changes in a real space. A workspace for *Kobito* was equipped with devices to interact with a real object below the workspace. For a new workspace, it must be equipped with a certain device to control a real object. Moreover, since *Kobito* is limited to interaction with predefined objects, it has difficulty responding to unknown objects.

To overcome the inconveniences, we present an interactive AR character to provide direct responses to real objects and to interact with users by using these objects. The interactive AR character interacts with real objects without reinstalling any spaces because each object is equipped with a device for the control of its own movement. The character sees how a user manipulates real objects and learns the way to control these objects. Finally, it can generate realistic response to the changes of a real object in real time.

Our approach enables interactive AR characters to have synthetic vision and autonomously perceive the change of physical or virtual objects in its view. It can memorize past experience and put knowledge to practical use for behavior decision. It is able to learn how to control any objects in its field by trying to act around the object.

The rest of this paper is organized as follows. We explain our interactive AR character's behavior. We outline the working environment and describe how AR characters interact with real and virtual objects in the environment. Then we present our system configuration and implementation. Finally, we conclude this paper and discuss possible directions for future work.

2 Interactive AR Character

An interactive AR character properly behaves with a real object according to several situations: a memorized behavior according to specific objects, a selected behavior by using relationship between predefined behaviors and attributes related with behaviors, and a selected behavior through perceiving the change of object from external pressure or one's own behavior.

Our AR character interacts with a real object by using properties related with the character's behaviors. The AR character controls a real object because it has the ability to see and learn how a user interacts with the real object. Based on the interaction history between a user and a real object, an interactive AR character learns the movability and the direction of movement of the object.

Interaction among existing objects (e.g., humans, animals, and physical objects) in real spaces should happen by external pressure and the law of physics or self-will. Because responses from the external pressure are decided by the direction of power and energy levels, we can simply decide the AR character's behavior. However, for the responses from self-will we need a mechanism to decide the AR character's behavior.

In this paper, we classify the cases to decide the AR character's behavior in three categories. In the first case an AR character already knows how to act for a physical object. In the second case, although the AR character senses attributes of the physical object, it does not know how to interact with the object. In the third case, the AR character does not know anything about the physical object. Our AR character has memory to store information about objects, attributes, and behaviors. The AR character decides a behavior for the first case by using the stored information. Because there are only attributes for an object in the second case, a behavior should be selected by using the relationship between predefined behaviors and attributes. An AR character should find out the most appropriate behavior through the change of object according to AR character's behaviors or the change of object from external pressure.

3 Working Environment

For our approach, we assume that the basic laws of physics apply to the augmented environment, which consists of AR characters, augmented objects, and physical objects. These elements may experience a collision, they may move and act according to condition of the collision. Physical objects, which are controllable by AR characters, are equipped with a micro controller unit (MCU), communication devices, motors, and so on. Each physical object includes features or a picture for recognition and tracking.

AR characters are virtually visualized 3D characters. We cannot touch them and recognizes them without a display device, but that only provides visualization and we cannot feel touch sensation. Therefore we need an arbitrator so that a user is aware of the existence of the character; the arbitrator enables the user to feel touch sensation indirectly. Objects in our augmented environment are made as toys, and a user can play with them and interact with AR characters by using them as an arbitrator. For automatic responses of our interactive AR characters, we assume that the AR characters know their behaviors and accumulate their experience through behaviors.

As shown in Figure 1, the system configuration for our interactive AR character responding to real objects consists of *Working Space* (WS) and AR *Character* (ARC). WS keeps track of changes of virtual objects and real objects and transmits the changes to ARC. ARC decides an AR character's behavior according to the information from WS and re-transmits a character's response to WS.

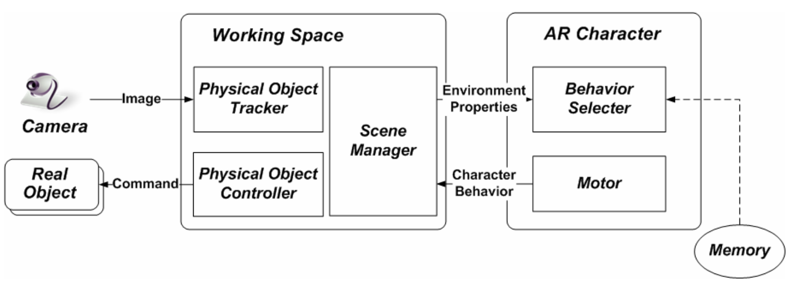


Fig. 1. System configuration

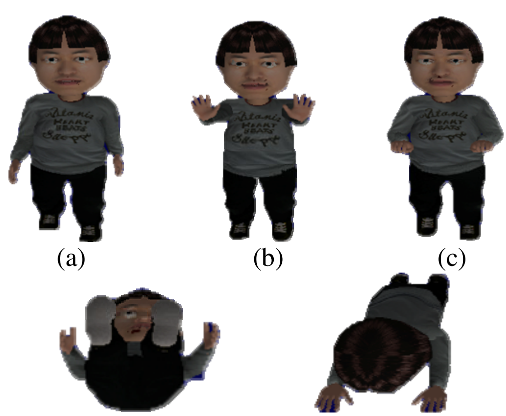
WS consists of three key components; *Physical Object Tracker* [7], *Physical Object Controller,* and *Scene Manager*. *Tracker* traces a real object and generates the ID and changed coordinate of the tracked object. *Scene Manager* manages all information in the working environment. First, it checks positional change of a real object inputted from *Tracker* and updates a real object's properties. Also it inspects collisions that occur between objects in the working environment. *Physical Object Controller* controls a real object in accordance with response inputted from ARC. ARC consists of *Behavior Selector, Motor*, and *Memory. Behavior Selector* selects a proper behavior by using information about behaviors in Memory. *Motor* visualizes 3D character and selected behavior. *Memory* stores behavior set and relationships among behaviors and attributes.

4 Implementation

We implemented these components as a prototype to allow us to consider interaction between an AR character and a physical object in a simple situation. We made ARMate as an AR Character and ToyCart as a physical object for interaction. ARMate has some behaviors and automatically acts according to situation. ToyCart is a controllable real object for ARMate. We used OpenSceneGraph Library as a 3D graphic toolkit, and used Cal3d and osgcal library for the animation of a 3D model. 3D models were made by using 3D MAX.

ARMate is an AR Character capable of behaviors such as walking, falling down backward, falling down, pulling and pushing (see Figure 2). There are some differences according to conditions for behavior Falling down backward and falling down are done by external pressure. Pulling and pushing are decided by self-will. However, *Behavior Selector* and *Memory* components implemented as prototype select regardless of the situation.

ARMate automatically moves toward ToyCart by calculating *angle* $\hat{d}$ of ARMate and *vector* $\dot{v}$ between ARMate and ToyCart. For accurate distance between them moving, the distance is calculated by using relative angle $\hat{b}$ between them, the two dimensional coordinates $(x_{toycart}, y_{toycart})$ of ToyCart, and the two-dimensional coordinates (x_{armate}, y_{armate}) of ARMate.

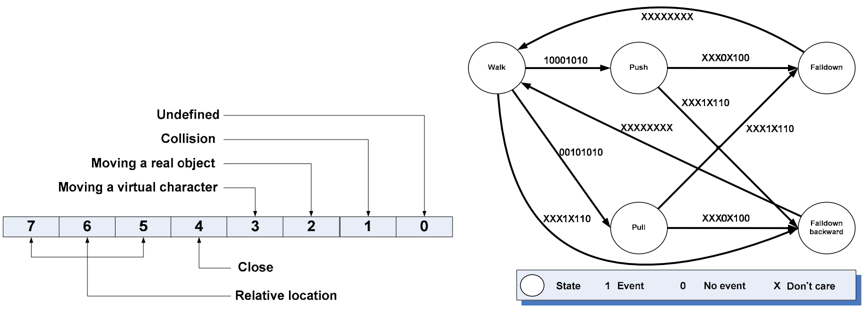


(a) (b) (c)

(d) (e)

Fig. 2. Behavior animation of ARMate: (a) *walking*, (b) *pushing*, (c) *pulling*, (d) *falling down backward*, and (e) *falling down*

ARMate has a situation register to store situation information related on a physical object such as relative position, collision, moving, and so on (see Figure 3 (a)). The register is used to select a behavior of ARMate at state diagram (see Figure 3 (b)). Walk behavior is the starting state and the state of ARMate can change from *Walk* to *Push, Pull, Falling down backward* according to the number of the situation register. Table 1 show the condition for the change of each state. There are no condition from *Falling down* and *Falling down backward* to *Walk*. The state is changed upon completion of animation time of *Falling down* and *Falling down backward*.



(a) (b)

Fig. 3. (a) Situation register and (b) state diagram for behavior decision

Table 1. Condition for the change of each state

Current State	Changed State	Condition
Walk	*Push*	- ARMate is at the rear of ToyCart - Not move ToyCart - ARMate is moving - Collision is detected - Not close
	Pull	- ARMate is at the front of ToyCart - Not move ToyCart - ARMate is moving - Collision is detected - Not close
	Falling down backward	- ToyCart is moving - Collision is detected - Close
Push	*Falling down*	- Collision is not detected - ToyCart is moving - Not close

Table 1. (*Continued*)

	Falling down backward	- Collision is detected - ToyCart is moving - Close
Pull	*Falling down*	- Collision is detected - ToyCart is moving - Close
	Falling down backward	- Collision is not detected - ToyCart is moving - Not close
Falling down	*Walk*	No condition
Falling down backward	*Walk*	No condition

We implement ToyCart as a real object controllable by ARMate and a user. ToyCart consists of two DC motors, a motor controller, a microcontroller (ATMEGA 8), and Bluetooth communication module (see Figure 4). A microcontroller controls Bluetooth signal and a motor control signal. A motor controller enables ToyCart to move backward or forward according to the signal from a microcontroller.

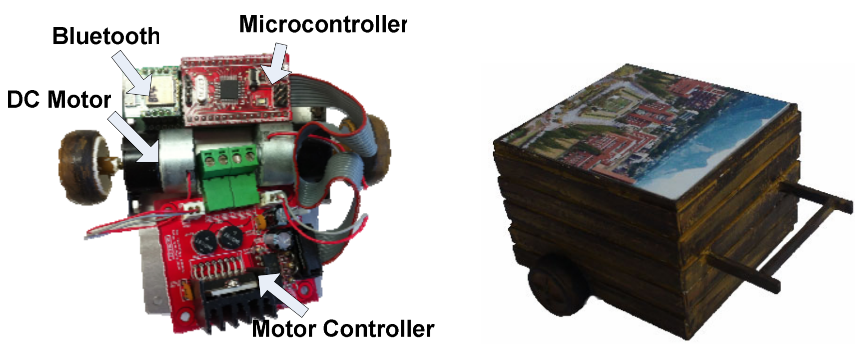
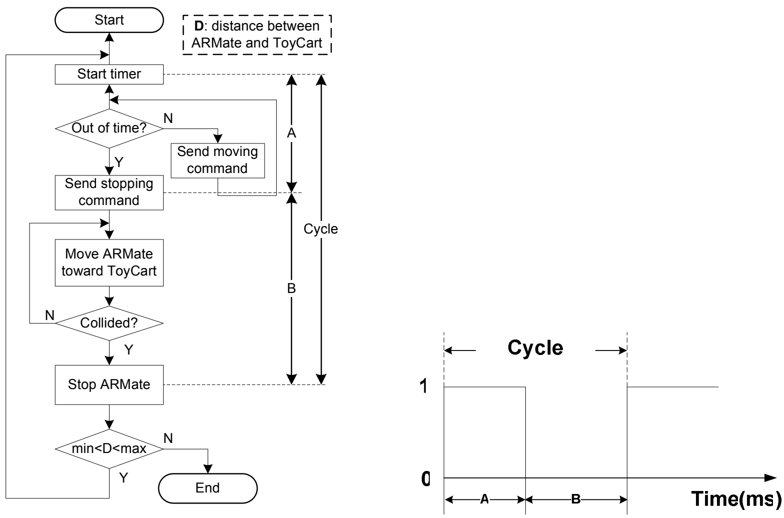


Fig. 4. Hardware configuration of ToyCart as a real object for interaction with a user and ARMate

When ARMate is in the *Push* or *Pull* state, ToyCart and ARMate have to move simultaneously for natural interaction. Figure 5 show the flow and timeline for simultaneous movement of ToyCart and ARMat. Because ToyCart is controlled by hardware devices, it is difficult for ToyCart to position at a specific location at a time. So we use a few time slices as a cycle to control ToyCart. ToyCart moves during A and ARMate moves during B (see Figure 5).

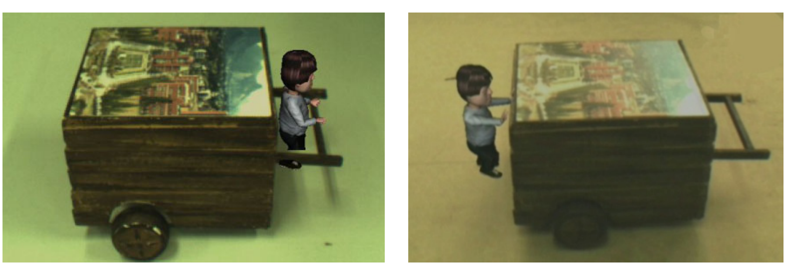


(a) (b)

Fig. 5. (a) The flow chart and (b) timeline for simultaneous movement of ARMate and ToyCart

5 Demonstration

We use two cameras to provide the user's view for demonstration. The user can move ToyCart toward various directions. Then, if a collision between ARMate and ToyCart occurs, ARMate falls down or falls down backward according to the direction of external pressure. Figure 6 shows interaction among ARMate, ToyCart, and a user. When ARMate is in front of or behind ToyCart, ARMate moves ToyCart using pull and push behaviors (see Figure 6(a) and 6(b)). When ARMate collided with ToyCart because it has been manipulated by a user, it behaves according to relative position and direction of the movement of ToyCart (see Figure 6(c) and 6(d)).



(a) (b)

Fig. 6. Demo screenshot: (a) pull, (b) push, (c) falling down backward, and (d) falling down

(c)

(d)

Fig. 6. (*Continued*)

6 Conclusion and Future Work

In this paper, we described an interactive AR character to provide direct responses to a real space and interact with users by using real objects. We implemented *ARMate* and ToyCart. ARMate presented some responses (e.g., walking, push, pull, falling down backward, and falling down) according to its own behavior set or changes in ToyCart manipulated by a user in real time. Through demonstration, we found that our AR character could enhance coexistence through the physical object-based interaction. In the second section, we mentioned three cases for AR character's responses. However we implemented ARMate as a prototype and applied it only to the first case. In future work we plan to implement the second and third cases for an intelligent AR character. We also plan to evaluate how much users experience immersion and realism in interaction with our AR character.

References

1. Anabuki, A., Kabuta, H., Yamamoto, H., Tamura, H.: Welbo: An Embodied Conversational Agent Living in Mixed Reality Space. In: Ext. Abstracts CHI 2000 on Human Factors in Computing Systems. ACM Press, New York (2000)
2. Barakonyi, I., Psik, T., Schmalstieg, D.: Agents That Talk And Hit Back: Animated Agents in Augmented Reality. In: Proc. ISMAR 2004, pp. 141–150. ACM Press, New York (2004)
3. Miyawaki, K., Sano, M.: A Virtual Agent for a Cooking Navigation System Using Augmented Reality. In: Prendinger, H., Lester, J.C., Ishizuka, M. (eds.) IVA 2008. LNCS (LNAI), vol. 5208, pp. 97–103. Springer, Heidelberg (2008)
4. Wagner, D., Billinghurst, M., Schmalstieg, D.: How real should virtual characters be? In: ACE 2006. ACM Press, New York (2006)
5. Barakonyi, I., Weilguny, M., Psik, T., Schmalstieg, D.: MonkeyBridge: Autonomous Agents in Augmented Reality Games. In: SIGCHI 2005, pp. 172–175. ACM Press, New York (2005)
6. Aoki, T., et al.: Kobito – Virtual Brownie –. In: SIGGRAPH Emerging Technologies (2005)
7. Baek, W., Woo, W.: Efficient Inter-camera Management for Multiple Objects Tracking in Mobile AR Environments. In: ICAT 2010, pp. 89–95 (2010)

The Application of Augmented Reality to Design Education

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Abstract. With the advances in computer technology, it is an inevitable choice for design educators to use digital tools to instruct students on subjects that are previously accomplished by face-to-face communication. The growth and dispersion of computer assisted instruction stimulate design educators to develop pedagogically effective learning models for traditionally studio-based design education to cope with the pressure of globalized competition and the demand for interdisciplinary cooperative communication. The main purpose of this study was to investigate how students interact with augmented reality models in design programs and to evaluate their perceptions regarding the representations in learning about 3D concepts. Key issues in computerized design education were explored and attention was given to the application of related augmented reality applications to smooth out the development of computerized design programs. The result of such an augmented reality application was evaluated and design students' best practice in action was reflected.

Keywords: Augmented Reality, Design Education, ARToolKit.

1 Introduction

The purpose of design education is to teach design students the essential skills of innovation, aesthetics and analysis. After graduation, the students can immediately engage in industrial design, product development and product planning. With the advances in computer technology, it is an inevitable choice for the design industry to use digital tools, to cope with the pressure of globalized competition and the demand of interdisciplinary cooperative design communication. It is necessary for design students to match up with the development of the design industry and the progress of digital technology by changing their egoistic design thinking and collaborating with other disciplines. Many design courses are associated with computers that integrate various media into teaching materials for design education. However, the success of interdisciplinary learning depends on the smoothness of communication among various disciplines. The purpose of this research is to use augmented reality in interdisciplinary design education to solve the problems of design communication in students

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from different backgrounds. Students' experiences accumulated in interdisciplinary communication could help to enhance their involvement in related businesses soon after graduation. As a result, developing time and cost could be reduced in a design team and business development could also be promoted.

Although the direct communication between students and teachers in the classroom works successfully, design educators are interested in introducing more productive and effective methods for improving the learning experience of students. The emergence of technological innovations such as web-based virtual learning environments has provided the potential for such purposes. Virtual learning applications can provide the tools to allow users to learn in a quick and happy mode by playing in virtual environments [1]. One of the most promising technologies that currently exist is augmented reality (AR), which is a variation of virtual reality (VR). VR technology completely immerses a user inside a synthetic environment. While immersed, the user cannot see the surrounding real world. In contrast, AR allows the user to see the real world, with virtual objects superimposed upon or mixed with the real world. Therefore, AR supplements reality, rather than completely replaces it. Ideally, it would appear to the user that the virtual and real objects coexist in the same space [2]. The main advantage of using AR is that design students can see and manipulate 3D objects in real time without the knowledge of traditional 3D modeling software. By perceiving and experiencing directly in three dimensions, spatial relationships could be comprehended better and faster than with traditional methods.

2 Literature Review

Designing 3D models is an important part of the design process and teaching with 3D models can improve content quality in design education. It is beneficial to allow design students to view design proposals as 3D entities as early in the process as possible. Previous works [3-7] explored the use of AR in education and its prospect. These works focused on presenting 3D graphical models to students, in order to assist them with complex spatial problems. However, the application of AR in design education was little explored [8]. There were applications for design collaboration, such as the utilization of 'sharing space' for the environment of 3D computer-supported collaborative work (CSCW) that strengthened the reality of designed objects and environments [9]. Augmented reality was used to increase designers' working space to observe their interaction in a virtual environment [10]. Designers were even provided with head-mounted displays to interact with 2D and 3D information [11]. However, portable and stand-alone augmented reality system was also developed with self-tracking and running on an unmodified PDA with a commercial camera [12]. Researchers proposed useful principles for the design of augmented reality from the viewpoint of product design to avoid pitfalls, which included the use of proper visual design techniques and the understanding of the user's experience. They also suggested that industrial designers should participate in the technical development of augmented reality [13]. Therefore, the development and application of augmented reality to design education is not only a technical issue, but also requires the collaboration of diverse design educators to make augmented reality more suitable to students' needs.

3 Research Design

This study compared AR-based design communication with traditional media by configuring a simple AR environment, and traditional 2D drawings were used in media presentation. The test subjects were specially chosen to represent interdisciplinary team members, such as design, management and engineering. Each group included three students from different backgrounds, and there were a total of six groups participating in this study. The platform was based on the augmented reality application ARToolKit, which is a tool for developing AR interfaces using computer vision based tracking with square markers. It provides AR tracking, virtual object overlay and simple interaction techniques. The only hardware required is a computer and a low-cost USB web camera. The requirements for a marker is that it must be square, must have a continuous border and the image inside the border must be asymmetric. The visual marker is detected in a live video stream, extracting the 3D position of the marker and its rotation.

The system utilized collaborative augmented reality as a medium for presentation, and used 3D models to facilitate design communication. The platform included a notebook and a camera for the detection of printed markers. By changing, moving and rotating the markers, 3D models were generated, superimposed and displayed on the screen. The system configuration is illustrated in Fig. 1.

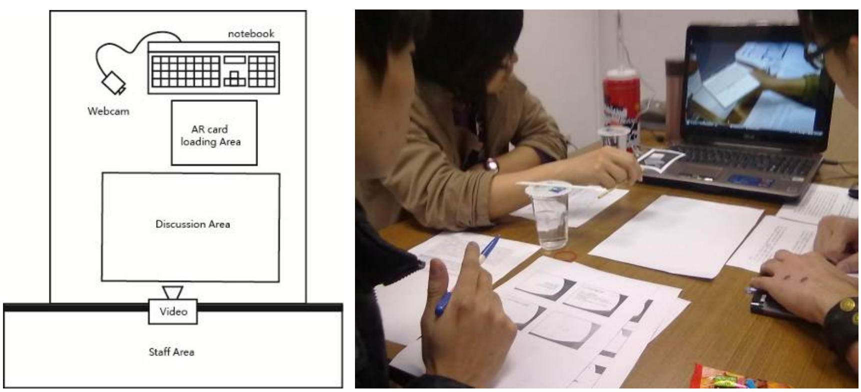

Fig. 1. The collaborative augmented reality system

4 Results and Discussions

The final implementation was evaluated by design students and the questionnaire for user interaction satisfaction (QUIS) was used to measure the quality and quantity of student interactions with the system. The overall mean for all questions was a 5.9 on a 1-9 Likert scale. The scale was arranged so that positive adjectives anchored towards 9 and negative towards 1. Comments and question ratings on the QUIS indicated areas for interface improvements. The quantitative questionnaire results were investigated further by focus groups and interviews. The results were positive, based on feedback from students. Users suggested several enhancements such as multitasking and interdisciplinary collaboration. Some students also indicated that the idea of using augmented reality to identify promising concepts might not be easy for novice users to grasp.

Feedback from the students revealed the following advantages of applying augmented reality to design education:

- AR-based models are 3D and can be moved in multi-directions conveniently.
- AR-based models can replace physical rough models.
- AR-based models can be rotated freely.
- AR-based models can be manipulated instantaneously to stimulate more design thinking than 2D drawings.
- AR-based models increase interactivity in design communication.
- AR-based models facilitate the understanding of spatial problems.

The system used AR as a 3D geometric manipulation tool and the focus lay on the collaborative aspect between students and teachers. The system could fill in the gap of visualization problems and lack of collaboration support by offering a way to visualize 3D models that were not only tangible, but also could be interacted with. Design students and teachers could view such models concurrently from different angles on a face-to-face basis. Presenting 3D models in the AR system could stimulate instant and intuitive interactions that encouraged exploration of new ideas. Material and colors of models could be changed instantaneously to reduce communication misunderstanding. Overall, the system brought about joys in designing, the capacity to realize designs, and a sense of accomplishment.

5 Conclusions

The result indicated that the use of augmented reality to support design education could be beneficial to students' learning. The design of system should be intuitive to use, portable, flexible, and should have much of the functionality of the current design pedagogy, in order to effectively improve learning outcomes and to shorten learning time. Intuitiveness is important in the context of both output and input devices. Without intuitiveness, input devices might mislead users and reduce learning effect while output devices could not improve learning ability simply by digitizing traditional pedagogical systems. Substantiating spatial and abstract concepts in system output is important for computerized design education to successfully increase students' learning outcomes in educational settings.

Augmented reality can present objects in a more intuitive way that is suitable for developing 3D educational programs for design, and allows design students to explore the full potential of design concepts, to evaluate 3D objects before anything is physically built. Students want to be empowered by technology and to apply their knowledge and experience to communicate designs that lead to improved results and greater personal satisfaction. The system can thus build a future in which students will experience competence, clarity, control, comfort, and feelings of mastery and accomplishment.

Acknowledgments. This work was sponsored by the National Science Council, Taiwan, under the Grant No. NSC99-2410-H-011-025-MY2.

References

1. Pan, Z.G., Cheok, A.D., Yang, H.W., Zhu, J., Shi, J.: Virtual Reality and Mixed Reality for Virtual Learning Environments. Computers & Graphics 30(1), 20–28 (2006)
2. Azuma, R.: A Survey of Augmented Reality. Presence: Teleoperators and Virtual Environments 6(4), 355–385 (1997)
3. Liarokapis, F., Petridis, P., Lister, P.F., White, M.: Multimedia Augmented Reality Interface for E-Learning (MARIE). World Transactions on Engineering and Technology Education 1(2), 173–176 (2002)
4. Fjeld, M., Juchli, P., Voegtli, B.M.: Chemistry Education: A Tangible Interaction Approach. In: Rauterberg, M., Menozzi, M., Wesson, J. (eds.) Proceedings of INTERACT 2003, pp. 287–294. IOS Press, Amsterdam (2003)
5. Kaufmann, H., Schmalstieg, D.: Mathematics and Geometry Education with Collaborative Augmented Reality. Computers & Graphics 27(3), 339–345 (2003)
6. Kaufmann, H., Csisinko, M., Totter, A.: Long Distance Distribution of Educational Augmented Reality Applications. In: Hansmann, W., Brown, J. (eds.) Proceedings of EUROGRAPHICS 2006, pp. 23–33. Blackwell, Oxford (2006)
7. Alcañiz, M., Contero, M., Pérez-López, D.C., Ortega, M.: Augmented Reality Technology for Education. In: Soomro, S. (ed.) New Achievements in Technology Education and Development, pp. 247–256. InTech, Vukovar (2010)
8. Liarokapis, F., Mourkoussis, N., Petridis, P., Rumsey, S., Lister, P.F., White, M.: An Interactive Augmented Reality System for Engineering Education. In: Pudlowski, Z.J. (ed.) Proceedings of the 3rd Global Congress on Engineering Education, pp. 334–337. UNESCO International Centre for Engineering Education (UICEE), Melbourne (2002)
9. Billinghurst, M., Weghorst, S., Furness, T.: Shared Space: An Augmented Reality Approach for Computer Support Collaborative Work. Virtual Reality: Systems, Development and Applications 3(1), 25–36 (1998)
10. De Michelis, G., De Paoli, F., Pluchinotta, C., Susani, M.: Weakly Augmented Reality: Observing and Designing the Work-Place of Creative Designers. In: Mackay, W. (ed.) Proceedings of DARE 2000 on Designing Augmented Reality Environments, pp. 81–91. ACM Press, New York (2000)
11. Regenbrecht, H.T., Wagner, M.T.: Interaction in a Collaborative Augmented Reality Environment. In: Terveen, L.G., Wixon, D.R. (eds.) Conference Extended Abstracts on Human Factors in Computer Systems, pp. 504–505. ACM Press, New York (2002)
12. Wagner, D., Schmalstieg, D.: First Steps Towards Handheld Augmented Reality. In: Narayanaswami, C. (ed.) Proceedings of the Seventh IEEE International Symposium on Wearable Computers, pp. 127–136. IEEE Computer Society, New York (2003)
13. Djajadiningrat, J.P., Overbeeke, C.J., Wensveen, S.A.G.: Augmenting Fun and Beauty: A Pamphlet. In: Mackay, W. (ed.) Proceedings of DARE 2000 on Designing Augmented Reality Environments, pp. 131–134. ACM Press, New York (2000)

Design and Application of the Augmented Reality with Digital Museum and Digital Heritage

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Abstract. This main purpose of this paper is to Augmented Reality with Digital Museum and Digital Heritage, using 3ds max modeling computer models to establish the components, and then output "Quest 3D" file to interior planning and layout, interactive virtual exhibition use Game engine, so that users can such as immersive have through the internet. This main purpose of this paper Virtual reality mode of operation is no longer confined to the input device, with the corresponding picture cards and use Webcam, that increased interaction 3D object is presented on the screen directly, can be enhanced and the effects can also be used in teaching. General antiquarian or art of teaching are related to video or computer rendered to 3D objects, teaching can be more active closer to the real, the student interest in learning and increase acceptance, the people into Virtual Reality Scene.

1 Introduction

Virtual Reality by Burdea (Burdea, G. and P. Coiffet 1993,1994) propose to define the functional characteristics of VR, he proposed the concept of VR Golden Triangle, the so-called VR should be interactive, immersion and Imagination , such as Figure 1. Virtual reality is a synthesis of computer graphics or video technology, combined with sound processing to produce a 3D virtual world of three-dimensional space, as users only need to play games in between as interact with the virtual world.

2 Virtual Reality Applications

Fig. 1. Zhu Ming - Taichi Series - Single Whip Augmented reality application

M. Chang et al. (Eds.): Edutainment 2011, LNCS 6872, pp. 25–26, 2011.

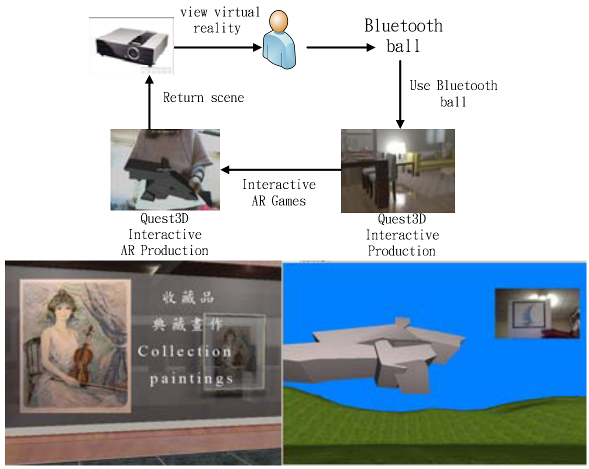

Fig. 2. System architecture and Applications of the VR

3 Expected Results

Combine reality and virtual reality, vision design concepts to change the presentation, clearly understand the idea of the designer communication cognitive divide. Presented in a way by Virtual Digital Museum, in order to display provided to the general user interface, enhance the communication process the design of interactive, and intuitive operation, improve the efficiency of communication,

Supporting the use of virtual reality space design and digital Museum, planning in the design flow to accelerate the recognition, and provides design tools to conduct a review, reduce the uncertainty of the design. Using the 3D game engine can effects more smooth, learners can quickly learn and apply in the discussions.

References

1. Azuma, R.T.: A Survey of Augmented Reality. Teleoperators and Virtual Environments, 355–385 (1997)
2. Azuma, R.T.: A Motion-Stabilized Outdoor Augmented Reality System. In: Proc. IEEE Virtual Reality, pp. 252–259. IEEE CSPress, Los Alamitos (1999)
3. Burdea, G., Coiffet, P.: Virtual Reality Technology. John Wiley& Sons, Inc., New York (1994)
4. Billinghurst, M., Belcher, D., Gupta, A., Kiyokawa, K.: Communication Behaviors in Colocated Collaborative AR Interfaces. Int. J. Hum. Comput. Interaction 16(3), 395–423 (1999)
5. Gillet, A., Sanner, M., Stoffler, D., Olson, A.: Tangible Augmented Interfaces for Structural Molecular Biology Computer Graphics and Application. IEEE Computer Graphics and Application 25(2), 13–17 (2005)

Effects of Multi-symbols on Enhancing Virtual Reality Based Collaborative

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Extended Summary. Applying virtual reality (VR) technologies to enhance learning becomes more and more popular. This research intends to investigate how multi-symbolic representations could help users being aware of collaborative context and partner's needs to enhance completing haptics-based collaborative tasks in a co-located/distant virtual environment. This study evaluates the performance of collaboration including the completing time and the number of failure in completing a task. To make users being aware of context, multi-symbolic representations in forms of color and text are provided as well as haptics and audio feedback in the virtual environment. Participants in the experiment were separated into four groups with the combinations of two variables: w/o multi-symbols and co-located/distant. The results show that multi-symbols significantly helped users reduce the time in completing a task in the case of co-located collaborative virtual environment. However, there was no significant improvement in performance in the case of distant collaborative virtual environment. From our on-site observations, while operating the task collaboratively, several interesting behaviors existing between participants, such as strategy toward task success or failure, were found. First, after a few trials of completing the task in the beginning, instead of pinching and lifting the virtual cube directly toward the cone-like target, participants first push the cube and slide it to the underneath of the cone-like target, and then lifted it upward till reaching the target. Namely, participants were able to develop a good strategy with less completing time or errors therefore to complete the task more efficiently and successfully even though it was in a virtual environment. Second, the failure in completing the task was generally caused by inconsistent and incoordinate movements or force between partners. While intending to pinch the virtual cube, a balanced force output from left side and right side is required to prevent the sliding. Furthermore, to investigate how multi-symbols could affect user's perceptions, we investigate the perceived awareness, presence and social presence of our proposed system and its influence on perceived usefulness, ease of use and playfulness based on Technology Acceptance Model. The results showed that awareness, presence and social presence significantly influenced perceived usefulness, ease of use and playfulness. Therefore, our proposed multi-symbols virtual reality system has potentials to help collaborative learning.

Keywords: Representations, Virtual Reality Collaboration, Social presence.

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A Virtual Computational Paper Folding Environment Based on Computer Algebraic System

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Abstract. Many people enjoy origami, an art of paper folding, since childhood. Origami is a more powerful geometry construction tool than straight and compass. But there are some inconvenience when you practice traditional origami on geometry. In this study, a computational origami environment has been developed. Huzita axioms are implemented with a computer algebra system (CAS). CAS not only deals with fundamental computation of axioms but also can prove some geometric consequences of folding steps. Furthermore, the process of paper folding is visualized. Users can observe the 3D animation of folding steps from different viewpoints.

Keywords: origami, computational origami, paper folding, geometry theorem proving.

1 Introduction

In high school, students study geometric constructions with straightedge and compass (SE&C), e.g., the construction of the perpendicular bisector of a line segment or that of an angle bisector. One can construct these geometric objects by SE&C operations. However, to trisect an angle or double the volume of a cube are impossible with SE&C [2]. Yet these problems can be solved with origami. There are many variations on the general theme of geometric constructions that use marked rulers and other tools for the construction of geometric figures. One interesting choice is the folding of a piece of paper for the purpose of geometric construction. Like SE&C constructions, paper folding is both academically interesting and practically useful, especially within the tradition of origami [6].

Origami is a traditional art of paper folding. In Japanese, the word "origami" means ori (fold) and kami (paper) [3].You can turn a piece of paper into a complicated object, like a boat or a crane. In general, origami works are complicated. People usually follow the instructions of illustrations from drill books [8]. In this paper, paper folding for geometric construction will be focused on.

There is a strong relationship between origami and geometry [6]. From the early history of mathematics, the correspondence between geometry and algebra has been an

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important subject of study. It is natural to investigate the algebraic properties of origami and relate them to geometric ones [9]. There is a theoretical interest in devising folding steps to achieve fraction of algebraic expressions, which overlaps with the area of geometric construction.

With the above considerations, a computer program is designed to perform and visualize paper folding, by extending our previous work on dynamic geometry environment (DGE) [11]. The original environment relies on a CAS, which can perform both algebraic and numerical computation, and logic programming, which provides pattern matching, tree-based data structure and automatic backtracking. This system can manipulate and reason about folding steps computationally and prove the correctness of geometric constructions.

2 Background

Origami, like geometric constructions, has many variations. It starts with a piece of square paper. As foldings are made, more and more features would be created on the paper, such as points, edges, crease lines and intersections.

There are three distinct notions in a folding action. First, a crease is to be made. It is called a fold line. A crease would separate one face into two regions. On one side of the line is the stationary region; the other region is the moving region [6]. Second, the stationary region and the moving region are to be decided. Third, the moving region is folded to the stationary region. The above three steps are called one fold (see Fig. 1). As more folds are made, the construction will become more complicated.

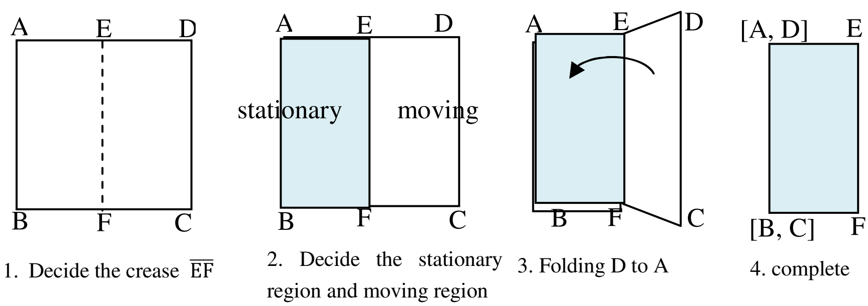


Fig. 1. Four steps of a fold

In computational origami, folding a piece of paper produces the results in some geometric properties. For example, given a rectangular piece of paper ABCD. After folding D to A and C to B (Fig. 1), $\overline{AE} = \overline{ED}$, $\overline{BF} = \overline{FC}$, $\overline{AD} \perp \overline{EF}$, and $\overline{BC} \perp \overline{EF}$.

2.1 Computer Programs of Origami

There are several methods to fold a piece of paper into a target model. One can follow a drill book step by step, or draw the creases on the paper, one fold at a time. This section introduces two well-known origami programs implemented with different methods.

TreeMaker

TreeMaker [7], a model-base origami software, was implemented with the tree method proposed by Robert J. Lang in 1993. This method supports designs of efficient and practical origami within a particular class of 3D shapes.

Most origamists decompose a folding process into two phases [10]:

(1) fold a “base” that puts roughly the right proportions of paper in roughly the right places, and (2) “shape” the base into the actual origami model.

Users can draw the target object as a graph. Then TreeMaker reduces the graph and finally generates the crease graph for folding. For example, if users want to create an object with 4 legs, one head and one tail, they can draw these flaps on a panel in TreeMaker. After TreeMaker reduces this graph, and generates the crease, users can follow the folding steps to get the target object.

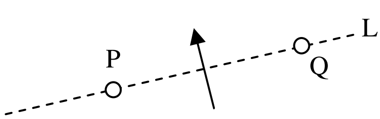
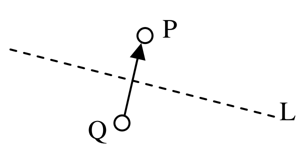
E-Origami System (EOS)

Another paper folding system was EOS [3], developed in 2002. It was built for research in constraint satisfaction and theorem proving. EOS is intended to be an integrated tool for constructing and reasoning about origami models. For this reason, they use Mathematica, a computer algebra system (CAS). Mathematica facilitates the manipulation of shapes of origami models both symbolically and numerically.

2.2 Six Huzita Axioms

In origami, there are some basic folding operations: fold a point to another point, fold a line to another line, put a crease through one or two points. There are thousands of ways to fold a paper. Since 1970s, researchers began to systematically enumerate the possible combinations of folds. The first systematic enumeration was provided by Humiaki Huzita [1]. He described six basic ways of defining a single fold by aligning various combinations of existing points, lines, and creases. These six operations were called the origami axioms of Huzita [1-2] (see Table 1).

Table 1. The description of Six Huzita Axioms

(O1) Given two points P and Q, we can fold along the crease L through them (Fig. 2).  **Fig. 2.** Axiom 1	(O2) Given two points P and Q, we can make a fold to bring Q onto P (Fig. 3).  **Fig. 3.** Axiom 2

(O3) Given two line, we can fold to superpose the two lines (Fig. 4).

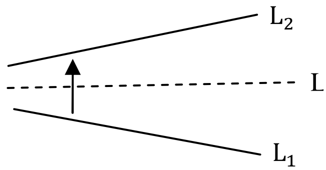


Fig. 4. Axiom 3

(O4) Given a point P and a line L_1, we can fold along the crease L that is perpendicular to L and passing through P (Fig. 5).

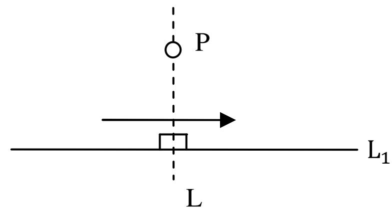


Fig. 5. Axiom 4

(O5) Given two points P and Q and a line L_1, either we fold along the crease L that passes through Q, such that the fold superposes P and L_1, or we can determine that the fold is impossible (Fig. 6).

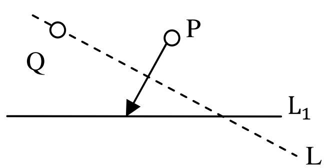


Fig. 6. Axiom 5

(O6) Given two points P and Q and two lines L_1 and L_2, we can fold along the crease, such that the fold superposes P and L_1, and Q and L_2 (Fig. 7).

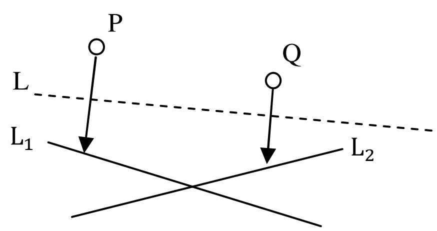


Fig. 7. Axiom 6

3 Computational Origami Environment

3.1 Origami and Geometric Constructions

Each Huzita axioms has its own geometry properties. Fadoua Ghourabi [8] used a formal language to define these axioms.

OnLine[A:Point, B:Line]: Point A is on line B.
SymmetricPoint[A:Point, B:Line]: The point symmetric to A wrt. line B.
Perpendicular[A:Line, B:Line]: Line A is perpendicular to line B.

Then the axioms can be defined formally as follows:

(O1). $\forall P, Q \in \text{Point}, \exists L \in \text{Line}, \text{OnLine}[P, L], \text{OnLine}[Q, L]$

(O2). $\forall P, Q \in \text{Point}, \exists L \in \text{Line}, \text{SymmetricPoint}[P, L] == Q$

(O3). $\forall L_1, L_2 \in \text{Line}, \exists L \in \text{Line}, \forall P \in \text{Point}, \text{OnLine}[P, L] \Rightarrow \text{distance}[P, L_1] = \text{distance}[P, L_2]$

(O4). $\forall \text{P} \in \text{Point}, \forall L_1 \in \text{Line}, \exists L \in \text{Line}, \text{OnLine}[\text{P}, L_1] \wedge \text{Perpendicular}[L_1, L]$

(O5). $\forall \text{P}, \text{Q} \in \text{Point}, \forall L_1 \in \text{Line}, \exists L \in \text{Line}, \text{OnLine}[\text{Q}, \text{L}] \wedge \text{OnLine}[\text{SymmetricPoint}[\text{P}, L], L_1]$

(O6). $\forall \text{P}, \text{Q} \in \text{Point}\ \forall \text{L}_1, \text{L}_2 \in \text{Line}\ \exists \text{L} \in \text{Line}$

$$\text{OnLine}[\text{SymmetricPoint}[\text{P}, \text{L}], \text{L}_1] \wedge \text{OnLine}[\text{SymmetricPoint}[\text{Q}, \text{L}], \text{L}_2]$$

With these predicates, we show how to use GeoProver [9] to implement most of them. GeoProver is an algebraic theorem proving package implemented with computer algebraic system. It uses Gröbner bases to process geometry theorem proving and provides the casual user with procedures that allow them to mechanize their own geometry proofs. According to the meaning of each axiom, we can use GeoProver predicates to express the first four axioms (Table 2).

Table 2. Implementation of Huzita axioms with GeoProver predicates. (L is the crease of each axiom)

Axiom	Geoprover scripts	
Axiom 1	L:=pp_line(P, Q)	
Axiom 2	L:=p_ bisector(P, Q)	
Axiom 3	L_1, L_2 is parallel	L_1, L_2 is not parallel
	O:=midpoint(M, P); R:=midpoint(M, Q); L:=pp_line(O, R);	I:= intersection_point(L_1, L_2); C:= incenter(N, Q, I); L:=pp_line(I, C);
Axiom 4	I := pp_line(M , N); Q:= pedalpoint(P , I); L:= pp_line(P, Q)	

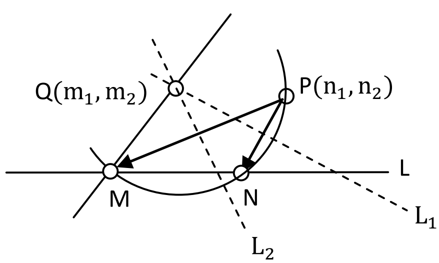


Fig. 8. Axiom 5

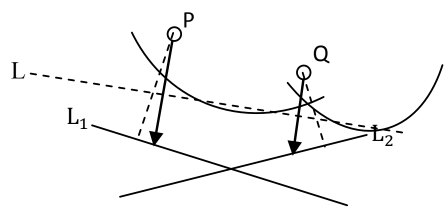


Fig. 9. Axiom 6

Axiom 5 and Axiom 6 cannot be expressed with GeoProver predicates directly.

Axiom 5 (O5) is equivalent to finding the intersection of a line L with a circle with a center Q and radius $\overline{QP}$, so it may have zero, one, or two solutions. If L is a tangent to the circle, there is one solution; if the line intersects the circle in two places, there are two solutions; else there is no solution (Fig. 8).

Axiom 6 (O6) is equivalent to finding a line simultaneously tangent to two parabolas, and can be considered equivalent to solving a third-degree equation. The two parabolas have foci at P and Q, respectively, with directrices defined by L_1 and L_2, respectively (Fig. 9).

4 System Architecture

This system is divided into three layers (see Fig. 10). The top layer is the package layer. The usage of these packages is build for specific domains, such as geometry theorem proving , physical environment, or origami. The middle is the module layer, which describes the functions provided by computer. If a system designer wants to design some package for visualization, s/he can include the drawing module. The bottom is the kernel layer, which contains the basic elements used in the module layer. For example, points and lines are the basic elements in the drawing module.

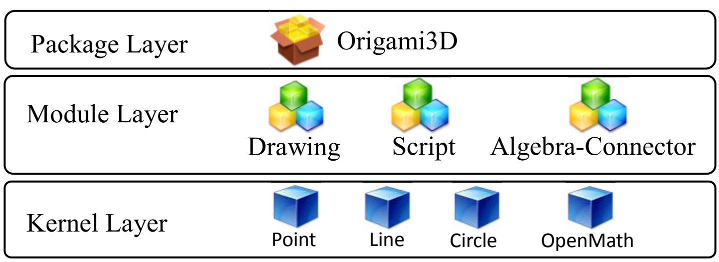


Fig. 10. The system architecture layers

Based on this architecture, a package named Origami3D is designed. In order to simplify the folding process, we also develop application programming interface for users to write simple scripts to implement sequential folding steps.

4.1 Origami Script

In traditional origami, each folding is a single step. If some basic scripts are provided, players can combine the scripts in various ways for their own goal.

```
createScene("A1", "L", "A")
createCanvas("Canvas", "A", "L", "A1", [width:500,height:500])
createPaper("A", "paper", [width:4,height:4,x:0,y:0,z:0])
VAR a1=creaseByAxiom2("A", "paper", "A", "B")
fold("A", "paper", "B", a1)
unfold("A", "paper")
VAR a5=creaseByAxiom3("A", "paper", "A", "I", "J", "I")          //Axiom 3
fold("A", "paper", "A", a5)
VAR a6=creaseByAxiom3("A", "paper", "B", "I", "J", "I")          //Axiom 3
fold("A", "paper", "B", a6)
foldAngle("A", "paper", "C", a1, 175)
VAR a7=creaseByAxiom2("A", "paper", "C", "J")                      //Axiom 2
foldAngle("A","paper","C",a7,90,[IMCJ])
VAR a8=creaseByAxiom2("A", "paper", "D", "J")                      //Axiom 2
foldAngle ("A", "paper", "D", a8, -90, [DKIJ])
```

Fig. 11. A script to produce an airplane

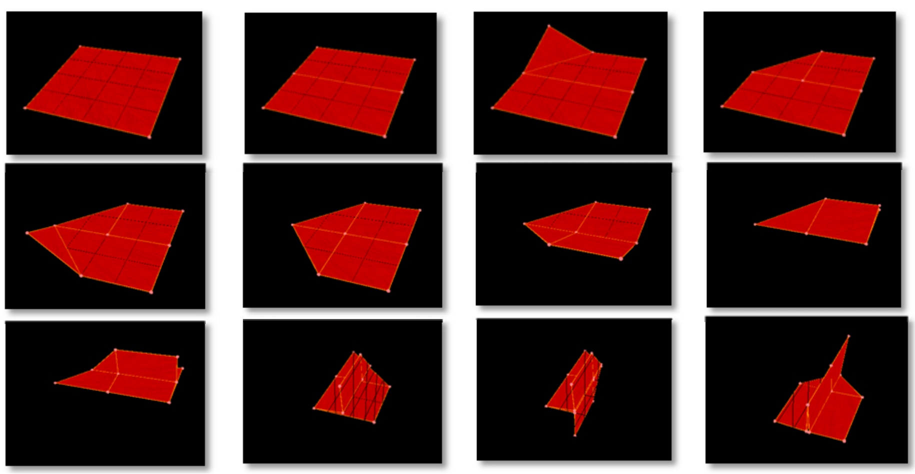


Fig. 12. The steps of the airplane script

4.2 Implementation of Folding Operations to Prove Haga Theorem

Kazuo Haga discovered that the side of a square can be divided at an arbitrary rational fraction in a variety of ways [12]. Haga's theorems say that a particular set of constructions can be used for such divisions. Few folds are needed to generate large odd fractions. The general form of the Haga construction is shown in Fig. 13. The relation between x, z and w follows:

$$z = \frac{2x}{1+x}, z = 2w \Rightarrow w = \frac{x}{1+x}$$

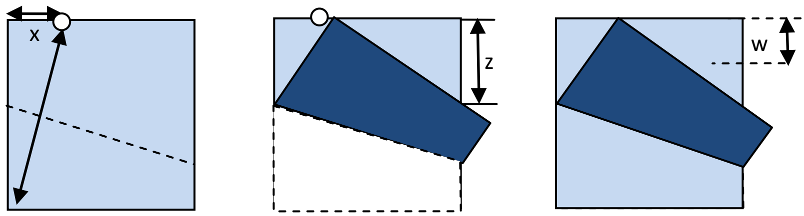


Fig. 13. Schematic of Haga construction

We can use the script in Fig.14 to implement this theorem.

```
createScene(“w”, “l”, “g”)
createCanvas(“Canvas” , “g”, “l”, “w”, [width:500,height:500])
createPaper(“g”, “paper”, [width:1,height:1,x:0,y:0,z:0])
VAR a1=creaseByAxiom2(“g”, “paper”, “D”, “C”)            // E, F
fold("g", "paper”, “D", a1);
unfold(“g”, “paper”);
VAR a2=creaseByAxiom2(“g”, “paper”, “B”, “F”)            // G, H
fold("g", "paper”, “D", a2);
unfold(“g”, “paper”);
VAR a3=creaseByAxiom2(“g”, “paper”, “A”, “G”)            //I, J
fold(“g”, “paper”, “A”, a3);
unfold(“g”, “paper”);
VAR m = intersection(“g”, “A”, “B”, “C”, “J”);
distance(“g”, “C”, “M”)                          //output the length between M,C
```

Output: The distance of C, M. From the equation (see equation 1) $x = \frac{1}{4}$, $z = \frac{2x}{1+x} = \frac{2}{5}$

```
>: 2/5
```

Fig. 14. Origami script of Haga theorem

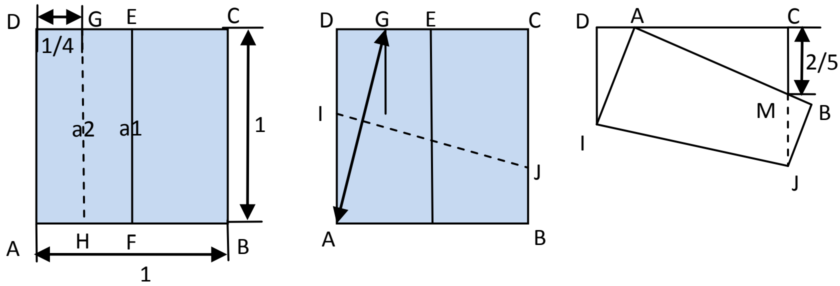


Fig. 15. Haga construction with the origami script in Fig. 14

5 Conclusion and Further Work

We have presented a computational origami environment. With simple scripts and algebraic formulas, this environment not only animates the folding operations in 3D, but also prove the correctness of geometry constructions. This system integrates geometrical constraint satisfaction, symbolic and numeric computing, so it can express geometric properties algebraically. The major challenge of the current system is that the number of polynomials grows very rapidly as the number of folds increases, which might consume too much of cpu time.

3D origami is more complex than plane origami. There are two major problems about 3D origami. First, the GeoProver package works on Euclid 2D Geometry. In 3D origami, a 3D GeoProver needs to be designed. Second, 3D origami needs its own 3D axioms. Currently the axioms are based on 2D geometry.

References

1. Huzita, H.: Axiomatic Development of Origami Geometry. In: Proceedings of the First International Meeting of Origami Science and Technology, pp. 143–158 (1989)
2. Hull, T.: Origami and Geometric Constructions, `http://kahuna.merrimack.edu/~thull/omfiles/geoconst.html`
3. Ida, T.: Proving and Solving in Computational Origami. LNCS, vol. 3249, pp. 613–628. Springer, Heidelberg (2004)
4. Ida, T., Takahashi, H., Marin, M., Kasem, A., Ghourabi, F.: Computational Origami System Eos. In: Proceedings of 4th International Conference on Origami, Science, Mathematics and Education, Caltech, Pasadena CA, p. 69 (2006)
5. Ida, T.: Origami Fold as Algebraic Graph Rewriting. Journal of Symbolic Computation 45(4), 393–413 (2010)
6. Lang, R.J.: Origami and Geometric Constructions (2003), `http://www.langorigami.com/science/hha/origami_constructions.pdf`

7. Lang, R.J.: A Computational Algorithms for Origami Design. In: 12th Annual Symposium on Computational Geometry, Philadelphia, pp. 98–105 (1996)
8. Ghourabi, F.: Logical and Algebraic View of Huzita's Origami Axioms with Applications to Computational Origami. In: SAC 2007 Proceedings of the 2007 ACM Symposium on Applied Computing, pp. 767–772 (2007)
9. The GeoProver Package for Mechanized (Plane) Geometry Theorem Proving, `http://www.reduce-algebra.com/docs/geoprover.html`
10. Demaine, E.D., O'Rouke, J.: Geometric Folding Algorithms, Part II. Cambridge University Press, Cambridge (2007)
11. Wong, W.-K., Yin, S.-K.: A Computer-assisted Environment for Understanding Geometry Theorem Proving Problems and Making Conjectures. Int. J. Intelligent Information and Database Systems (IJIIDS) 3(3), 231 (2009)
12. Kazuo Haga's First Theorem, `http://www.northwestmathconf.org/NWMC2007/NotesHaroldJacobs/Hagas_First_Theorem.pdf`

Physically-Based Virtual Glove Puppet

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Abstract. Glove puppetry in Taiwan is a popular performing art. In this paper, we present a physically-based virtual glove puppet system which simulates the dynamics of glove puppet and allows user to interactively observe and manipulate the motion of the virtual puppet. With physics simulation techniques, we can generate realistic motion of the virtual puppet with high-level inputs. In our system, the puppet is modeled as a multi-body object with many degrees of freedom among parts. The physical simulation of the puppet clothes is controlled by a mesh, which is used to define a set of particles and limitations among them. Furthermore, we apply texture and normal maps to clothes to enrich the appearance. We demonstrate the effectiveness of our system by showing a plausible running motion of the virtual glove puppet and various styles of puppet costume in our system.

Keywords: physically-based simulation, computer animation, virtual reality in education.

1 Introduction

Glove puppet show is an important performing art in Taiwan. It combines essential of music, story-singing, sculpture, painting, embroidery and architecture. A successful puppet show requires the art of manipulations by puppet master to control the puppet with fine and precise hand motions. It takes many years of learning to master the manipulation of glove puppet. It is even a more difficult task to generate puppet motions as an animation in a computer because it consists of secondary motions in many parts that are not directly controlled by the performer. In other words, it is an interesting challenge to simulate the dynamics of glove puppet in computer animation, especially the cloth dynamics. If we can build a virtual puppet system for realistic animations, we will be able to archive the cultural heritage by recording the script, music, and performance of the glove puppet in a digital way. The convenience of digital technologies has facilitated the teaching of glove puppet and promoted the tradition art as shown in the work of Lin et al. [1].

The motion simulation of digitalized puppet is most related to the research in the field of computer animation [2]. There are three mainstream methods in computer animation including *keyframe* animation, *data-driven* animation and *procedural* animation. Several studies have tried to combine the advantages of different approaches. For example, Chen et al. [3] proposed a procedural character animation method taking data from motion capture devices and using them as the parameters in an animation

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procedure. Beside the above methods, physical simulation is another common technique to generate realistic motions with relatively high computation cost. Fortunately, modeling and simulating the physical property of an animated object are becoming prevailing due to the fast development of physics engines and hardware devices such as GPU (Graphics Process Unit).

The objective of this paper is to design a physics simulation system capable of showing realistic motions of a glove puppet. It can reproduce the puppet shows in the virtual world by adopting an appropriate dynamics model close to the real world. Fig. 1 shows the architecture of the proposed system. First, we use 3ds Max to build the cloth mesh of the puppet, and UVW mapping is used to attach the texture map and normal map for appearance accordingly. The texture and normal maps were designed by using an image editing software for the color and surface variation of the puppet's cloth. Then we can export the geometry and texture information of our model for the use in our program. Second, we use PhysX [4] as the physics simulation engine in our system. Our system contains three main components under PhysX dynamics including *rigid body*, *joint* and *cloth*. With the system, a user can manipulate the puppet and observe the generated motions in various parts of the model, including body and cloth.

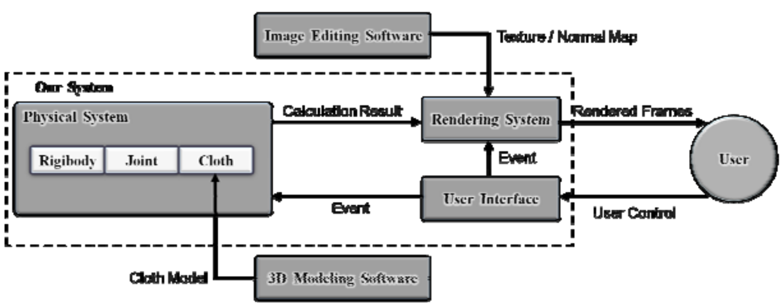


Fig. 1. The architecture of our system

2 Physics System

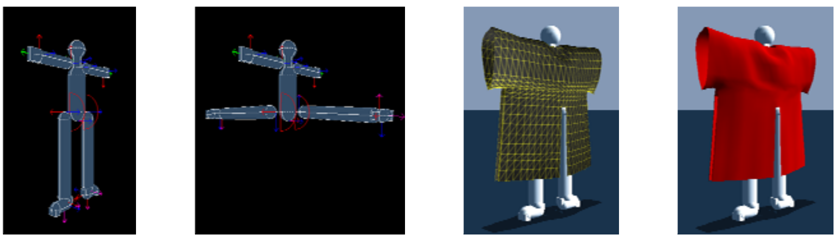
The basic structure of a real glove puppet includes the body and the cloth. The body is composed with a hollow head, cloth body, cloth legs, woody palms and shoes. The puppet master manipulates the motion of a glove puppet by applying global hand movement and using fingers to control the head and upper limbs to generate expressive motions.

In our system, we treat the head, upper limbs, legs and shoes as the basic components in rigid-body dynamics (see Fig. 2 (*a*)). The relative motion of connected parts is regulated by joints to restrict the rotation angle and translational distance. Through physics simulation, the motion of a virtual puppet can be generated to respect the physical law in the real world.

2.1 Rigid Body and Joint

The ideal rigid body is a solid geometry in which deformation can be ignored. The external force will not change the distance between any two points inside the rigid body. The shape and physical properties of an object are two basic elements for the construction of rigid-body dynamics. Two ways are commonly used to build a rigid body: (1) from geometry primitives: box, sphere and capsule; (2) from convex and triangle meshes. The model of the virtual glove puppet in our system is a complex rigid body system composed of multiple rigid-body parts as shown in Fig. 2 (*a*).

Each rigid body requires the modeling of several physical attributes to simulate the dynamics of the system. When two rigid bodies collide, these attributes can be used to determine whether the rebound will occur or not. These physical attributes include: position, density, restitution, static/dynamic friction, velocity, and angular velocity. The restitution and friction will affect energy loss when the rigid body moves. When an external force is given as an input, the PhysX engine is used to process the simulation to achieve desired effects.



(a) (b) (c) (d)

Fig. 2. The initial (*a*) and the limit (*b*) state of the joint skeleton. The mesh (*c*) and the puppet clothes without texture (*d*).

Joint is a location to regulate the rotation and translation between two connected rigid bodies. PhysX offers all kinds of simple joint mechanisms, such as revolute joint, spherical joint, point-on-line joint, pulley joint and so on. It is easy to combine the rigid bodies into a whole puppet by joints, and then define the DOF of each joint to restrict the movement of the puppet. We have also added the motor and spring attributes to the physics simulation.

2.2 Motion

Body language plays an essential role in a glove puppet show because the facial expression of wood carved head is immutable. The puppet motion is divided into two categories in our system: the *primary* motion and the *secondary* motion. Secondary motions are the one driven by other primary motions. For example, when a puppet moves up and down, its legs will swing back and forth. The leg swing motion is a secondary motion. In contrast, the movement of the puppet itself is a primary motion. In this system, a primary motion is controlled manually by a procedure or by user input while a secondary motion is computed by physical simulation. We indirectly control the secondary motions by using the physical attributes in a simulation. Therefore, it is crucial to specify correct parameters for these physical attributes. However, it is difficult to directly measure the attributes (such as mass, friction and so on) of each component. Therefore, we have conducted extensive experiments to tune the physical parameters to make the generated motion plausible compare to the real motion.

3 Cloth

Glove puppets are usually designed to express its characteristics through different costumes. It is crucial to be able to simulate the dynamics of cloth in order to enhance the puppet motions in a puppet show. We have implemented the cloth with geometry model and textures for different costumes. The physical attributes of cloth are also defined by mesh which includes the position of cloth particles (vertices) and constraints between these particles (edges). The attributes of the cloth include bending stiffness, stretching stiffness, density, thickness, friction and damping. In our experiment, stiffness, friction and damping dominate the energy loss of motion.

While the cloth mesh defines the internal physical property of a costume, texture mapping is used for cloth appearance. We use a planar projection in the UVW mapping to build the correspondence from 2D texture image to 3D cloth geometry. We scanned the pattern of a real puppet and edited the texture image by some image editing software. If we only use a single image for texture mapping, it will only give the cloth mesh color appearance. To reflect the surface variance of cloth, we adopt normal maps with local Blinn-Phong Illumination [5] to simulate the bumps and wrinkles on the cloth surface. The OpenGL shading language [6] is used to implement the bump mapping for the shading result in a real-time interaction. Two costumes for glove puppet with different textures and normal maps are show in Fig. 3.

(a)

(b)

Fig. 3. The leftmost images are Taoism costume (a) and female attire (b) of real puppets. The second column is the imitation of the real, and the rightmost two columns are the details of the imitations.

4 Results

Running is a fundamental motion in the glove puppet show. Several complex motions can be extended from the running motion. We simulate the running motion by repeating the virtual puppet moves upward and downward. The running motion can then be produced by leg swinging. Based on the appropriate settings of physics attributes, a virtual puppet's feet can swing back and forth as a response to the vertical movement of a puppet. Fig. 4 gives the simulation result of the virtual puppet compared to the real puppet running.

In the user interface, we have used mouse scroll to control the position of puppet. We have also used sensor device (such as Wii remote) to manipulate the puppet. A user can directly control the puppet to learn the running motion. With such a system, we expect to be able to archive more realistic feedbacks and be helpful in teaching and learning how to play glove puppet.

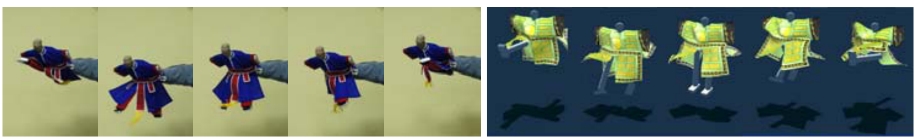


Fig. 4. The running motion sequences of a real puppet (*left*) and our results (*right*)

5 Conclusions and Future Work

In this work, we present a virtual puppet system with physics-based motion simulation and bump-mapping materials for the puppet's clothes. In this system, a user can control the running motion of the virtual puppet interactively, and practice the skills of puppet manipulation. We hope this virtual puppet system can preserve and promote the art of glove puppet show. Furthermore, it will be interesting to combine the real and virtual puppets together to create a new form of puppet show.

Furthermore, we hope to extend our system in several ways. We focus only on the running motion of the puppet in the current system. But we are interested in adding walking, rolling and back flips motions into our system and making a virtual show. For the cloth, further studies will focus on investigating decoration and variation of texture, and we can also add some decorations like headdress and flag to reflect the characteristics of different roles. Besides the puppet, some stage props, like horse, table, chair and even the show platform, can make our work more complete in establishing the new form of performing art with glove puppet shows.

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References

1. Lin, C.C., Li, T.Y., Hou, G.C.: An Initial Investigation of Using Computer Animation to Assist Puppetry Learning – Using Hand Puppet Show as an Example. In: Proc. of the 13th Global Chinese Conf. on Computers in Education (2009)
2. Rick Parent Computer Animation: Algorithm and Techniques. Morgan Kaufmann Publishers, San Francisco (2002)
3. Luo, Z., Chen, I.M., Yeo, S.H., Lin, C.C., Li, T.Y.: Building Hand Motion-Based Character Animation: The Case of Puppetry. In: Proc. of 2010 Intl. Conf on Cyberworlds (2010)
4. NVIDIA Corporation.: PhysX Documentation (2008)
5. Heidrich, W., Seidel, H.P.: Realistic, Hardware-accelerated Shading and Lighting. In: Proc. of the 26th Annual Conf. on Computer Graphics and Interactive Techniques, pp. 171–178 (1999)
6. Rost, R.J., Licea-Kane, B.: OpenGL Shading Language, 3rd edn. Addison-Wesley, Reading (2009)

Potential of Second Life for Psychological Counseling: A Comparative Approach

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Abstract. The present study explores the potential of Second Life as an alternative channel for university psychological counseling. The media affordances of traditional face-to-face counseling, internet counseling and Second Life counseling were rated along nine distinct features identified as most relevant to psychological counseling. Data collected from a group of 312 university students are being analyzed at the present time. Results shall be able to empirically examine the comparative affordances of the three counseling channels and the potential of Second Life for psychological counseling.

Keywords: media affordances, psychological counseling, second life.

1 Introduction

There are many approaches to psychological counseling. Traditional counseling is usually taken place in a face-to-face fashion. With the fast advancements of computer and network technologies, internet counseling in the forms of e-mail, electronic bulletin boards, instant messaging and internet chat rooms, and so on, has been made available [1-3]. Nevertheless, non-verbal messages, which are considered crucial contextual cues in interacting situations somehow affect its wide-spread implementation and adoption. In light of virtual reality's media affordances, the present study intends to explore the potential of Second Life as an alternative channel for psychological counseling. Two research questions are examined: 1. Are there significant differences among traditional face-to-face, internet and Second Life counseling along prominent media features? 2. If so, in what dimension(s) and how?

2 Methods

For the purpose of the study, a counseling center with different rooms has been built in Second Life. Particularly, three styles identified as most inviting by university students [4] have been built: a traditional style, a western tarot emphasis and a naturalistic aura (Figure 1). In addition, six counselors with different genders, age ranges

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and styles have been created based on university students' liking (Figure 2) [4]. A lobby has also been created to allow clients to choose which counselor they prefer to hold the session with and in which room.

Fig. 1. Counseling rooms with different styles

Fig. 2. Counselors with different genders, age ranges and styles

Five groups of university students were purposively sampled. Participants (N=312) were directed to rate the relative affordances of the three counseling channels after a 30-minute introduction session. Nine media affordances identified as most relevant for psychological counseling [3] were included: anonymity, modifiability of personal appearance, selectability of helpers, interactiveness between dual parties, convenience and flexibility in time, convenience and flexibility in place, seclusiveness of counseling site, diversity of counseling sites, and availability of various counseling objects as aids. Collected data are being analyzed at the present time.

References

1. Lei, Y.M.: Issues on Real-Time Individual Counseling in Cyberspace. Student Guidance 56, 100–109 (1998)
2. Wang, C.H., Lin, C.W., Liu, S.H., Yang, C.F., Ling, X.Y.: A Survey Research Study on the Development of Cyber Counseling Services in Taiwan. Bulletin of Educational Psychology 39(3), 395–412 (2008) (in Chinese)
3. Yu, F.Y., Chang, B., Hsieh, H.T., Chen, Y.Y.: A Preliminary Study on the Use of Second Life for Career Counseling. In: Proceedings of the 18th International Conference on Computers in Education, pp. 568–570 (2010)
4. Hsieh, H.T, Yu, F.Y., Chang B., Chen, Y.Y.: A Pilot Study on the Application of Immersion Technology to University Counseling—Second Life as the platform. Paper presented at Taiwan E-Learning Forum (2010) (in Chinese)

Constructing a 3D Virtual World for Foreign Language Learning Based on Open Source Freeware

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Abstract. In hopes of finding an appropriate way to integrate virtual worlds into Computer Assisted Language Learning (CALL), this paper introduces a 3D virtual platform for language education set up by OpenSimulator and Moodle. The resulting 3D virtual world can not only create a graphic immersive context for students to practice language use, but also offer teachers a better management tool to keep student records and teaching content. Furthermore, some teaching aids and learning tools are developed to support language learning and teaching, and three types of task-based instructional activities are designed to offer an appropriate, appealing and meaningful context where the target language can be acquired naturally with less anxiety. We hope that the 3D virtual world can be an option for the English classroom to provide students an input-rich and immersive environment where learning can be fun.

Keywords: Computer Assisted Language Learning (CALL), virtual worlds, simulation and game, OpenSimulator (OpenSim), Moodle.

1 Introduction

As modern language-learning techniques aim to help students move beyond basic mastery of structures towards communicating meaning in real situations [1], social interaction has become essential to language learning. According to communicative language teaching, it is important for learners to develop the ability to use language to communicate meaning, and language teachers need to provide students with a context for genuine communication [2]. Unfortunately, foreign language learners so far have little opportunity to practice the target language in an authentic and meaningful context. A potential solution to this problem may be to apply 3D virtual worlds where students can immerse in the target language by interacting with objects or other students using avatars. Through the game-like tasks, the 3D virtual platform could provide a carefree, motional environment for apprentices of language use where students may learn languages more interactively, in less time, and with less expense than by visiting countries that speak the target language.

This paper introduces a contextualized and playful 3D virtual world for language learning set up by two open source trends -- OpenSimulator and Moodle. As an open source multi-platform, multi-user 3D application server, OpenSimulator offers a free

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and safer option than Second Life for hosting a virtual world. Compatible with Second Life, OpenSimulator is a 3D virtual world where users can interact with each other through avatars. Combining OpenSim with Moodle, a course management system, would ease teachers' management of students and teaching materials in the 3D virtual platform. With the two free open source systems, the 3D virtual world can be constructed and the new platform can be explored.

2 Three-Dimensional Virtual Worlds for Foreign Language Learning

Three-D virtual worlds are multimedia, simulated environments often managed over the Web, which users can inhabit and interact in via their own graphic, self-representations known as avatars [3]. Combined with interactive 3D graphics, simulation technology, virtual reality, and Voice over Internet Protocol (VoIP), 3D virtual worlds were first employed in the gaming community and gradually adapted to the educational field. They are viewed as an arena with potential for language learning and teaching because of their rich digital media and immersive environments to provide users the limitless ability to communicate, collaborate, and explore [4].

Two of the most widely used 3D virtual worlds for language learning are Active Worlds (AW) and Second Life (SL). Through discourse analysis, Toyoda and Harrison [5] investigated negotiations of meaning between students and native speakers of Japanese in AW, and sorted them into nine categories according to the causes of the difficulties. Peterson [6] conducted a preliminary study to examine the communication features of undergraduate English language learners' avatars and interactional strategies used in AW, concluding that "the application of virtual worlds in CALL offers new opportunities to engage learners in the kind of interaction that may facilitate the development of second language competences" (p. 38).

Since Linden Lab launched SL in 2003, it has been recommended as an appropriate platform for the development of language proficiency, collaborative and intercultural learning contexts. Molka-Danielsen et al. [7] developed a language course in SL, and the preliminary results of their study showed that "students are motivated to participate and may wish to spend even more time in-world. It shows the setting is believable enough, that the role play can be related to real life situations" (p. 105). Through an open-ended question survey on 15 Spanish learners in an American university, Hislope [8] concluded that SL may be a beneficial resource that allows students a wider array of conversational opportunities and cultural experiences. Deutschmann and Panichi's [9] discourse analysis on their doctoral online oral proficiency course indicated that students became more active in signaling involvement as the course progressed, and teachers' supportive linguistic behavior is important in increasing learner engagement. Henderson et al.'s [4] investigation on 100 Chinese beginning learners in an Australian university showed significant improvements between students' pre and post self-efficacy ratings. Through tandem chat discussions between Chinese and American students, Wang, Song, Xia and Yan [10] found that the Chinese EFL participants perceived SL as a useful and interesting language learning platform, and wished to use it for EFL learning more often in the future. Analyzing seven EFL Japanese students' conversations in SL, Peterson [11] suggested that the virtual worlds elicit a high degree of participation and learner-centered interaction and various use of discourse management strategies. The results of pre- and post-study questionnaires also reflected the learners' positive feedback and high level of motivation and interest.

Although research on the use of 3D virtual worlds for foreign language learning is limited and many areas remain unexplored, researchers are recognizing the potential of virtual learning environments to facilitate language acquisition and cross-cultural understanding [11]. The above studies reveal a number of potential advantages of utilizing 3D virtual worlds for language learning.

3 Implementation of 3D Virtual Worlds for Language Learning

OpenSimulator and Moodle were combined to set up the 3D virtual world for language learning. OpenSim, an open source version of SL, offers the 3D virtual environment, while Moodle, a course/content management system (CMS), provides the course materials and student content. The combination of the two open source systems can provide not only the affordance of a 3D virtual world, but also a friendly interface for course and content management to make teaching and learning more interactive and give educators a valuable tool to use.

3.1 OpenSimulator

Although signing up and interacting in the SL environment is free of charge, administrating a private space or island, creating permanent objects and uploading images or audios are not. In order to possess a permanent space, a premium membership, land purchase and maintenance fees will become a sizeable expenditure over time. In addition, the SL environment remains relatively insecure because of the freedom to roam and the relative anonymity of SL. First released in 2007, OpenSim can be used to simulate virtual environments similar to Second Life, and is getting more stable as it approaches release 1.0. There are hundreds of OpenSim-based virtual worlds in different languages with thousands of users, such as OSGrid, Francogrid, and Avination Grid. As an open source application, OpenSim is especially suitable for research purposes because by setting up a private server, we can have experiences without unnecessary influence to others [12]. Therefore, OpenSim was selected to build our server platform for hosting the 3D virtual world. With a view for sustainability and scalability and to provide a safe environment for students and teachers, a standalone OpenSim server was set up in our university on consideration of expense and internet connection with the help of the Institute for Information Industry.

Scenes and landscapes were created on the OpenSim server to produce a 3D virtual world with avatars and synchronous text and voice communication. There are nine islands so far. Six of them are built for language teaching: Welcome Island (Orientation), Around Town (shopping mall, hospital, supermarket, bank, restaurant, and MRT), and CSI (bank and police stations/labs), Ideas City (hotel, airport, stores, and little gardens), Ideas Community (campus, church, and Chinese garden), and Educasim (group discussion areas, parks, and lakes). The other three islands are for system and testing purposes: Sloodle Island, NTNU sandbox, and Engschool.

3.2 Moodle and Sloodle

Moodle is a popular contemporary open source Course/Content Management System. It contains activity modules (such as quiz, chat, and assignment) to build richly collaborative communities of learning and deliver content to students [13]. However, continuous enhancements in computer technology have resulted in a new generation of students that expect increasingly more from their e-learning experiences [12]. Sloodle was created to meet educators' need for additional tool sets to support learning and teaching in a virtual world.

Sloodle (Simulation Linked Object Oriented Dynamic Learning Environment) is a free open source project which integrates the multi-user virtual environment of SL with Moodle. Students are able to take quizzes and surveys, submit assignments, record chat conversations, and keep track of their progress via a points system all viewable from within SL. We hope that a combined use of Moodle and OpenSim through Sloodle may allow teachers to explore new teaching approaches on the web and within 3D virtual worlds.

3.3 Teaching Aids and Learning Tools

In order to support language learning and teaching, some teaching aids and learning tools are developed and installed in the 3D virtual world. They include:

- Map and Vocabulary HUD: Map HUD is used to teleport to different places while Vocabulary HUD provides the pronunciation and word form of the objects (Figure 1).
- Word card: Vocabulary and example sentences are presented with their pronunciation upon clicking an exclamation mark (Figure 2).
- Slide Screen: Powerpoint slides or pictures that can be put into the screen for presentation (Figure 3).
- Non-player character: Chat bots that can interact with students (Figure 4).
- Object database: A list of ready-made objects which can be sent to the teachers' inventory in a few clicks.
- Sloodle set: Sloodle provides a suite of tools to enhance learning and teaching. The Sloodle set includes: Choice Horizontal/Vertical, Login Zone, Meta/Picture Gloss, Prim Drop (assignment), Quiz Chair, Quiz Pile-On, RegEnroll booth, and Web Intercom.

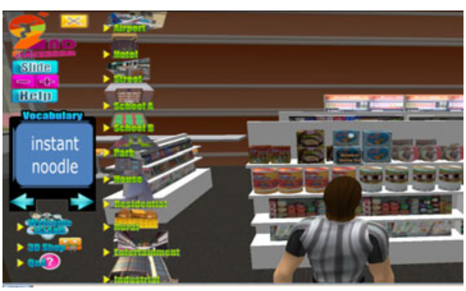

Fig. 1. HUD of map and vocabulary system

Fig. 2. Word card

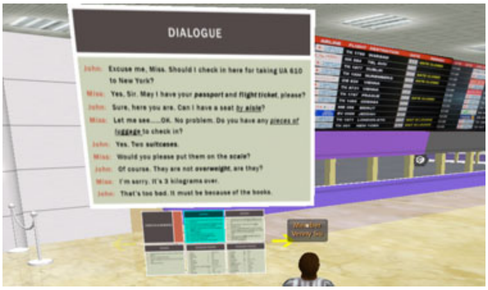

Fig. 3. Slide screen

Fig.4. Non-player character

4 Instructional Activities in 3D Virtual Worlds for Language Learning

The 3D virtual world for language learning is designed to facilitate English learning by integrating the virtual environment into the curriculum with interesting scenario-based tasks since learners prefer learning by playing and engaging in multi-playing gaming and competitive interactive tasks. Through experiencing a virtual world, learners can interact with objects and other users to expand their linguistic knowledge and gain communicative competence in a meaningful context [14]. As 3D rendering and real-time voice communication technologies are integrated in the 3D virtual world for language learning, it becomes possible to design more interactive, immersive and communicative language learning activities. Currently, three types of instructional activities have been designed as follows.

4.1 Scenario-Based Activities: English Study Tour

Based on the scenes created in the 3D virtual world for foreign language learning, we designed a series of English study tour lessons including: Airport (check-in, customs and immigration), Hotel (check in/out), Campus (university orientation), House/Apartment (rent/visit a house or an apartment), Mall (go shopping), Restaurant (order/eat food), Hospital (see a doctor), Bank (open an account). Table 1 is a sample of tasks and goals for the airport scenario, and the lesson plan for each scenario will contain:

- Presentation screens with a model conversation and vocabulary.
- Vocabulary objects with pronunciations and word forms which can be clicked on and allow interaction.
- Video or audio resources for listening comprehension.
- Note cards with grammar explanation or teachers' reminders automatically given to students.
- Role play: Tutor-student or student-student role plays.
- Game-like tests: Vocabulary hunt and NPC chatbot.
- Assessment: Vocabulary quiz, conversational quiz, and listening quiz in the Moodle system.

Table 1. Tasks and goals for the airport scenario

Task	Goals
1. Check in and boarding	Learn to check in at the airlines counter and find the boarding gate
2. Buying duty-free	Learn to buy things and conduct a shopping conversation
3. Safety video and pre-flight and captain's announcements	Listening and understand the safety video and announcements
4. Going through customs	Learn to go through customs
5. Going through immigration	Learn to go through immigration
6. Car rental and money exchange	Learn to rent a car and exchange money

4.2 Collaborative Role-Play Missions

Based on collaborative learning, some problem-solving situations are designed as group activities to develop students' communicative competence through role-playing scenarios. The group size can vary depending on the students' confidence levels and language proficiency. Table 2 describes some example missions.

Table 2. Collaborative missions in the 3D virtual world for foreign language learning

Mission	Task description
Ask about lost luggage	(Role A) Student: You cannot find your luggage after arriving at the airport. (Role B) Airline staff: Apologize and assure to send the luggage to his/her hotel as soon as possible.
Hotel room service	(Role A) Student: At midnight, you are hungry and call for room service. (Role B) Hotel staff: Take the order for room service.
Complain about food	(Role A) Student: You are not satisfied with the food in the restaurant. (Role B) Restaurant staff: Try to convince the student of the good quality and service the restaurant provides.
Ask for directions	(Role A) Student: On your way to a scenic spot, you get lost and ask for directions. (Role B) Local citizen: Try to help the tourist find their way.
Job hunting	(Role A) Student: During a working holiday, you want to find another job and interview with employers. (Role B) Employer: The student is not qualified for the job. Let him/her know the truth.

4.3 Virtual Quests and Games

Web Quests are a task-based method where learners are guided through the use of the web to discover and explore a topic. The incorporation of 3D virtual worlds into Web Quests offers a more exploratory approach to language learning, where the learner engages in social, immersive and creative activities [15]. Some language quests and games are designed and built to interest and engage students in the 3D virtual world. The virtual quests and games currently available are: CSI detective missions (see Figure 6), word puzzle ball, and scavenger hunt. Furthermore, some classroom games can easily be employed into the 3D environment such as guess who I am, and Simon

Fig. 5. CSI detective missions

says. All these games can not only motivate students but also engage them in language learning.

The 3D virtual world provides true contextual learning involving real places with real meaning to students. Through the above instructional activities, students can experience traveling to a foreign country to use the target language in different scenarios, playing different roles to solve real-life problems, and playing games to learn languages. Their vocabulary should be expanded through manipulating and interacting with the objects with visual and audio aids. Their reading, listening and speaking abilities will also be improved through communicating and interacting with tutors, classmates and other designed objects in this immersive context.

5 Conclusions and Future Research

Although integration of 3D interactive technology into ESL or EFL teaching and learning is still in its infancy, studies have shown its potential for language learning and teaching. The 3D virtual world for language learning set up by OpenSim and Moodle present a dynamic, motivating and engaging context for language learning and teaching. Three types of task-based instructional activities are also designed to engage students to interact with classmates or animated characters in the 3D virtual world. These tasks require them to do things, to read directions, to interact with other avatars, to travel over the landscape, and thus to learn the target language.

This paper focuses only on the design and construction of a virtual world for language learning. The 3D virtual environment is considered as a means of establishing a concrete context to practice language skills, rather than practicing words and phrases from a textbook. Our next step will be to bring EFL students to this virtual world to carry out the task-based activities and investigate their performance as well as their attitudes towards language learning in the 3D virtual world.

Virtual worlds cannot replace actually communicating with native speakers in the real world. However, while the time, money and native speakers for real world language learning are not available for all language classrooms and learners, the 3D virtual worlds may be an option to provide a viable supplement to traditional textbook instruction to create experiences that help students understand places, people, language and processes better [16]. They are a new medium for communication and will continue to evolve and become easier to use. Virtual worlds for language learning provide teachers and students an opportunity to explore and experience new communication channels and learning environments.

References

1. Littlewood, W.: Communicative Language Teaching. Cambridge University Press, New York (1981)
2. Sullivan, P.: Practicing Safe Visual Rhetoric on the World Wide Web. Computers and Composition 18, 103–121 (2000)
3. Minocha, S., Reeves, A.: Designing Learning Activities in Second Life for Student Engagement. In: The 4th and FINAL Open CETL Conference, The CETLs: Celebrating Teaching and Learning, pp. 15–16. The Open University, Milton Keynes (2009)
4. Henderson, M., Huang, H., Grant, S., Henderson, L.: Language Acquisition in Second Life: Improving Self-efficacy Beliefs. In: Proceedings Ascilite Auckland 2009, pp. 463–473 (2009)
5. Toyoda, E., Harrison, R.: Categorization of Text Chat Communication Between Learners and Native Speakers of Japanese. Language Learning and Technology 6(1), 82–99 (2002)
6. Peterson, M.: Learning Interaction in an Avatar-based Virtual Environment: A Preliminary Study. PacCALL Journal 1(1), 29–40 (2005)
7. Molka-Danielsen, J., Richardson, D., Deutschmann, M., Carter, B.: Teaching Languages in a Virtual World. In: Proceedings of NOKOBIT, pp. 97–109. Tapir Akademisk Forlag, Oslo (2007)
8. Hislope, K.: Language Learning in a Virtual World. The International Journal of Learning 15(11), 51–58 (2008)
9. Deutschmann, M., Panichi, L.: Talking into Empty Space? Signaling Involvement in a Virtual Language Classroom in Second Life. Language Awareness 18(3-4), 310–328 (2009)
10. Wang, C., Song, H., Stone, D.E., Yan, Q.: Integrating Second Life into an EFL Program in China: Research Collaboration Across the Continents. TechTrends 53(6), 14–19 (2009)
11. Peterson, M.: Learner Participation Patterns and Strategy Use in Second Life: an Exploratory Case Study. ReCALL 22(3), 273–292 (2010)
12. Andreas, K., Thrasyvoulos, T., Stavros, D., Andreas, P.: Collaborative Learning in OpenSim by Utilizing SLoodle. In: 2010 Sixth Advanced International Conference on Telecommunications, pp. 90–95 (2010)
13. Livingstone, D., Kemp, J.: Integrating Web-based and 3D Learning Environments: Second Life Meets Moodle. The European J. for the Informatics Professional 9(3), 8–14 (2008)
14. Shih, Y.-C., Yang, M.-T.: A Collaborative Virtual Environment for Situated Language Learning Using VEC3D. Educational Technology & Society 11(1), 56–68 (2008)
15. Vickers, H.: VirtualQuests: Dialogic Language Learning with 3D Virtual Worlds. CORELL: Computer Resources for Language Learning 3, 75–81 (2010)
16. Jung, H.J.: Virtual Reality for ESL Students. The Internet TESL Journal 8(10) (2002)

Analysis of Brainwave Characteristics for Playing Heterogeneous Computer Games

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Abstract. The traditional E-learning often offers the online examination to assess the learning effect of a student after completion of the online learning. Basically, this traditional learning assessment mechanism is a passive and negative assessment mechanism, which cannot provide an real-time learning warning mechanism for teachers or students to find out problems as early as possible (including such learning conditions as "absence of mind" resulting from poor learning stage or physical or psychological factor), and the post-assessment mechanism also cannot assess the learning effectiveness provided by the online learning system. This research paper attempts to acquire the electroencephalogram to analyze the characteristic frequency band of the brainwave related to learning and formulate the learning energy index (LEI) for the learner at the time when the learner is reasoning logically via the brain-wave detector based on the cognitive neuroscience. With the established LEI, the physical and psychological conditions of an online leaner can be provided instantly for teachers for assessment. Given that the learning system is integrated into the brainwave analytic sensing component, the system not only can provide learners an instant learning warming mechanism, but also help teachers and learning partners to further understand the causes of learning disorder of learners, and can also provide relevant learning members with timely care and encouragement. From the analysis of the experimental results, it is to prove that the game-based learning has not only the energy distribution of the characteristic frequency band the same as that by using professional textbooks, but also the way of game design can enhance the LEI of learners more in the aspect of training logical reasoning.

Keywords: Cognitive neuroscience, Learning energy index, Electroencephalogram, Game-based learning.

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Game-Based Mobile Learning System for Campus on Android Platform

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Abstract. This paper proposes a game-based mobile learning system for both indoor and outdoor learning in campus which could enhance the self-directed learning for students. In this paper, we propose the system design and the learning activity that will be incorporated into the two and half dimentional campus environment. The navigation features of our system are useful for situation learning in a natural environment. By using game-based learning method, we hope that students will learn more in depth information and get more knowledge by their own interests.

Keywords: Mobile & Ubiquitous learning, self-directed learning, android platform.

1 Introduction

With the rapid development of mobile devices and technological advancement, there is an opportunity to use mobile devices for learning [1] due to the fact that mobile nature of hand telephony and the ease of communicating.

In mobile learning research, there are a variety of studies focusing on informal learning, life-long learning, just-in-time learning, and situated learning. However in seeking to cater for the learning needs of young adults, game-based learning apraches have been popular to engage learning while still enjoying learners' satisfaction. There are already some mobile systems that integrate playing and learning [2-4], which is called game-based mobile learning. In these games, mathematical problem solving is embedded in an artificial game context, while the mobile technology making it possible to situate problem in their natual context without losing the motivational benefits of games [5]. Also the game-based mobile game could promote decision-making skills and engage young adults in lifelong learning [6-9].

Thus, the main aim of this study is to develop an interactive, animated and informative mobile system about both indoor and outdoor activities in the two and half dimentional campus environment of Shandong university, while appealing to the

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students as a learning tool. By using location-based services, it can provide the current location of the user, which could help the user be aware of the surrounding environment and make the learning activities more efficient in the outdoor setting. On the other hand, students could also break the limitation of space, especially for the university with many campuses, students could join classes at anywhere by using the mobile devices.

This paper is organised as follows. Section 2 elaborates the system and learning activity design. Section 3 describes the system architecture and implementation. Section 4 describes the platform evaluation and results. The final section outlines the summary of the outcomes of this study.

2 System and Learning Activity Design

Mobile technologies could be applied on a number of devices, such as mobile phones, smartphones, PDAs, netbooks, tablet PCs and so on. The Google-led Android platform becomes a major application developer as its compelling open-source software stack compared to other platforms, such as apple. So our system is applied on android platform and the SDK we used in this system is android 2.1.

Our system's language is in Chinese and is targeted for the university students of Shandong University, which includes seven campuses. Students could use the application on mobile devices to enter different campuses or do learning activities at anywhere. In order to make users immerse into the learning environment, the system uses the two and half dimentional campus environment and the diamond map. We take application in the softeware college campus as an example.

In order to make the system more safe, students need to use their real name and student ID to login the system (see Figure 1). After users entered, they could choose a role to load in the system. Their charater could walk and roam inside the two and half dimentional environment of the campus (as shown in Figure 2). The 2D small map of the whole campus is shown on the top right corner, which can be folded and unfolded. The buildings, outdoor structures, and roads are drawn on the 2D map for way finding purposes. Users can jump to the right place in 2.5D scene rapidly by clicking the places in the 2D small map. The mobile device user also has the ability to zoom in and out (see Figure 2), and move the 2.5D scene in order to see the rest of the whole campus.

Fig. 1. User's login interface

(a) (b) (c)

Fig. 2. Two and half dimentional campus environment. (a)(b)Zoom in view; (c) Zoom out view.

Users could also enter buildings in the campus and check classes' timetable of different lecture room, if they choose one class, they could enter classes online to download courseware, home work or other learning files. Even more, they could watch the teaching video, if the teacher uploaded before or students upload on class (As shown in Figure 3). By using this system, information are attached to the 2.5D scene, which makes users easier to find information. Students needn't cost one or more hours on their way to other campuses to sit in on a class, they could attend their interested classes at anywhere or review the lecture after class. On the other hand, the system offer an intruduction of indoor learning activities, users could enter the nearby classes after check the system.

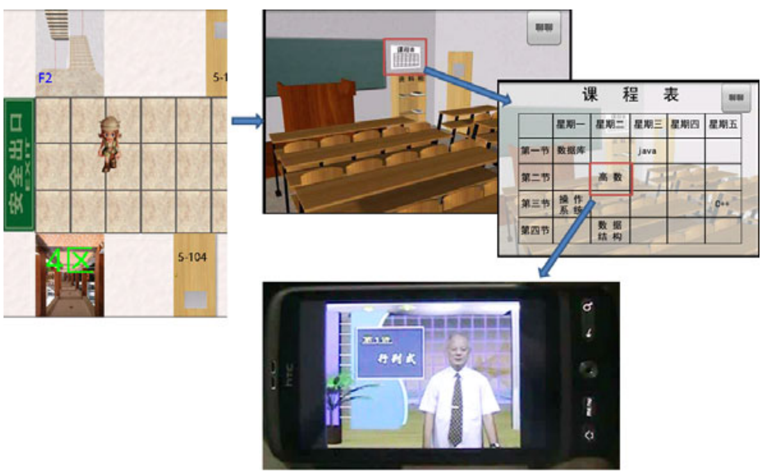

Fig. 3. Indoor learning

The system utilizes the GPS feature of the mobile device and could display the current location of the mobile device user in outside (as shown in Figure 4). With this information, the users will know what outdoor activities are nearby and how to travel to the happening places. Also users could find nearby students, and make group flexibly, which make the communication more convenient.

Fig. 4. GPS location of the mobile device user

What's more, in order to make the communication and interaction more convenient, we embed chatting room and memorandum book to the system (see Figure 5). User's could create or enter a chatting room, and communicate with others, which make group learning more convenient, especially for those groups with one goal to finish a task. Users could also create their own memorandum book to record the classes they choose, or any other activities in this learning environment.

Fig. 5. Left: Chatting room. Right: Memorandum book

To understand the procedure of the game play, we should first present the tasks. The system includes many tasks, which could be classified as object oriented tasks and experimental tasks. Object oriented tasks were attached to an object in the learning scene, once a player comes near to the object, such as an equipment, the electronic attachment becomes visible to him. The experimental tasks are designed by teachers or senior users, these tasks were usually attached to a class. Users could make groups to finish the task and upload their works online for evaluation.

When finishing the tasks, players could be devided into teams, including information groups and on-site groups. The information group includes one or more palyers who play the game in the classroom with both mobile device and personal computer. On the other hand, the on-site group includes one or more players playing the game outside the classroom using one or more mobile devices. The information group focused on problem solving with the help of online resources by PC and the guidance and feedback of on-site groups. And the on-site group provides field information and data relevant to problem solving by watching for hints and signs, taking photos, video and audio clips and uploading them to the platform as a solution to the task or source material for the information group. Information and on-site groups could communicate with each other through chatting room tool of the mobile device.

3 System Architecture and Implementation

It can be seen from Figure 6 that our system uses client/server architecture. In the mobile client side, students are equipped with wireless network-connected mobile devices in one-to-one basis. The system utilises the 3G and WiFi networks connections and records students' learning and personal data on the server-side component. Teachers or administrator can monitor the technological layer on their teacher's version of the fractions software in order to see the available students for the activity or do data management by PC.

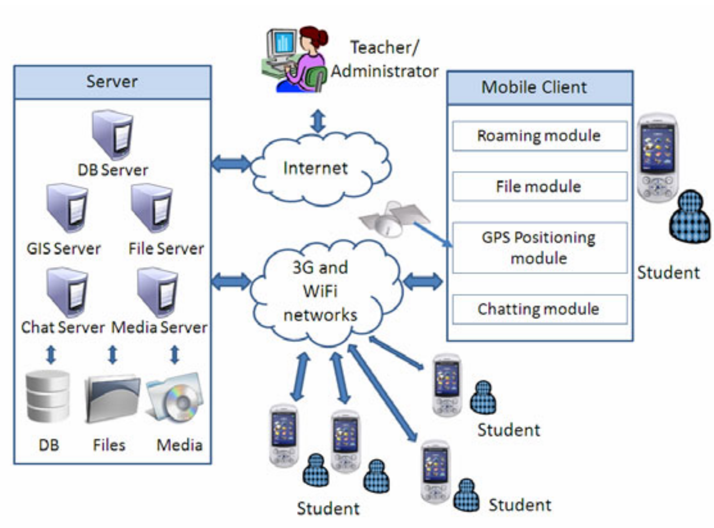

Fig. 6. System Client/Server architecture

3.1 Server Side

The server side is composed of some data servers, including database server, GIS server, file server, chat server, and media server. Different service could be set on different PC. If one server needs to be repaired, other servers could still be available. The main functions of each server are as follows:

1) The database server is the core of the whole server side. User's learning and personal information are all stored in the database, such as the login information, user's tasks, user's classes and other servers' information. This server takes in charge of the connection of the client side and the database, the client side and each server, the administrator and the database, and the administrator and all servers.

2) The GIS server is used to detect the user's location. And the location information is also stored in the database. When the GIS server is open, the positions of mobile users could be got by GPS. The server compute the correspondence coordinates on the diamond map of the system. What's more, the server could also compute the nearby users and return back to current user.
3) The file server is used to upload and download files to the server side from the client side. "Socket" is used to read and write binary files when uploading files. And downloading services is by Tomcat. Once one file is uploaded to the server side, the record of this file is written to the database and be signed as "non-acceptable". The files status could be changed as "acceptable" after it passing the administrator's check. Then this file could be moved to the downloading files by the file server.
4) The chat server is relatively independent of other servers, which is in charge of making a chatting space for multi-users.
5) The media server is also a file server, which stores media information, such as teaching video, and this server also provides online view services for these media.

3.2 Mobile Client Side

The mobile cilent side uses socket to communicate with the server side. We create a main service to accept request from client side then send to the server side, and wait for message reture. Data in client side is stored by internal memory or by XML file on disk. As shown in Figure 7, the server side mainly includes the roaming module, GPS positioning module, file module and chatting module. Different modules uses handler to communicate with each other.

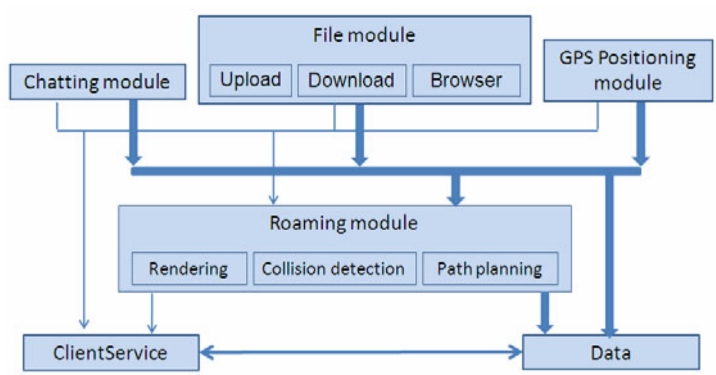

Fig. 7. System Client side architecture

1) The roaming module is the kernel of the client side, which is the also the entrance of other modules. The roaming module is mainly in charge of the rendering of the whole two and half dimensional scene. In order to make the user's roaming more realistic and easier to move to the destination, collision detection and path planning are added between users and objects inside the scene.

2) The chatting module only has one socket class, when the module is activated, users could enter the right room they choose.
3) In file module, each file transfer operation needs to start a new thread in service. Upload or download operation in dependent on the type transfered by the handler. Also this module supports the overview of txt files, images, MP3 or MP4 files.
4) The GPS positioning module aquires user's latitude and longitude from the satellite, then sends to the server side to compute the coordinate in the 2D map of the scene in the system.

3.3 Administrator Side

The background management system for teachers or administrator is developed by java on PC (see Figure 8). Administrator could use this sytem check database or files on server side, including users' information, class information and so on. Administrator could change or delete the information of users or examine and verify the files uploaded by users. Administrator could also monitor on-line users, and send public informatin for users according to their positions and so on. For example, the administrator could inform the students in a class that the timetable is temporarily changed.

Fig. 8. The background management system

4 Platform Evaluation

We had conducted a simple user test for 39 undergraduate students in the campus. The experiment took place in the software college of Shandong University. The technical equipment used consisted of MS windows-based PCs and three types of mobile phones with android 2.1 system: MOTO XT702, SAMSUNG i9088 and HTC Desire G7 A8180. Teachers were asked to give devises and observe students while they were playing in the game. All game participants were given a 5 min demonstration of the system and some instructions. Each participant should perform at least three tasks during the test. We do evaluation in the following aspects first: user interface intuitivity, user control and freedom, system reliability/responsiveness and general impression and usability. The evaluation score is on the Likert scale (1-very poor, 2-poor, 3-neutral, 4-good, 5-very good). The average scores are given in Table 1. It is easy to see that the user control and system reliability are not good so far. We should improve these parts in future. What's more, we do another survey for participants, more than 80.5% students prefer to download this system on their mobile phone, and think this system has advantages during their studing.

Table 1. Evaluation results

Evaluation criteria	Score
User interface intuitivity	4.5
User control and freedom	3.7
System reliability/responsiveness	3.4
General impression and usability	4.8

5 Conclusion

In this project, we are building two and half dimentional environment of the campus for interactive learning. By using this game-based learning system, students could learn by their own interest, make their own learning plan, find learning friends to do group learning at any time or any where. We will do more user test for the learning effects of this system. We hope students could learn more in depth information and get more knowledge by using this system.

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References

1. Churchill, D.: Learning objects for educational applications via PDA technology. Journal of Interactive Learning Research 19(1), 5–20 (2008)
2. Savill-Smith, C., Kent, P.: The Use of Palmtop Computers for Learning, A Review of the Literature. LSDA, London (2003)
3. Facer, K., Joiner, R., Stanton, D., Reid, J., Hull, R., Kirk, D.: Savannah: mobile gaming and learning? Journal of Computer Assisted Learning 20, 399–409 (2004)
4. Cogoi, C., Sangiorgi, D., Shahin, K.: mGBL-mobile game-based learning: perspectives and usage in learning and career guidance topics. eLearning Papers 1(1), 1–6 (2006)
5. Schwabe, G., Goth, C.: Mobile learning with a mobile game: design and motivational effects. Journal of Computer Assisted Learning 21, 204–216 (2005)
6. Mitchell, A., Inchingolo, P., Vatta, F., Gricar, J., Cisic, D., Petrovic, O., Kittl, C., Peyha, H. J.: Mobile Game-Based Learning to promote decision-making skills – a pan-European project. mGOV (2006)
7. Mitchell, A., Inchingolo, P., Vatta, F., Gricar, J., Cisic, D., Petrovic, O., Kittl, C., Peyha, H. J.: Designing mobile games to promote decision-making skills – a pan-european project. MIPRO (2006)
8. Mitchell, A., Cisic, D.: Using mobile game-based technologies to engage young adults in lifelong learning. MIPRO (2006)
9. Fabricatore, C.: Learning and Videogames: an unexploited synergy. AECT (2000)

Bayesian Network to Manage Learner Model in Context-Aware Adaptive System in Mobile Learning

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Abstract. Ubiquitous learning is of interest to many researchers and developers to build adaptive course for learners at anytime and in anywhere. To create personalized learning content suitable for each learner, one challenge is to manage and evaluate the learning model, known as the learner's profile. Our previous study represented a model of CAMLES [1] system which is a personalized context – aware adaptive system in mobile learning to support students to learn English as a foreign language in order to prepare for the TOEFL test as a case study in Vietnam. This paper represents how to apply Bayesian Network in order to manage learner model which is a key factor to determine the learning content adaptation for the learner's demands and knowledge of individual learners. Uncertainty factors used to determine the level of understanding of learners for each concept in the content model.

Keywords: Bayesian Network, context-awareness, adaptive system, CAMLES.

1 Introduction

The development of mobile devices, especially mobile phones is booming now. Especially there is an upward trend in mobile applications in the areas of modern life such as communication, entertainment, banking and education. In particular, academic knowledge on the mobile phone is an important direction of research in the field of e-learning. One of the benefits of mobile learning (m-learning) is the ability to provide and access learning materials at any time in anywhere. CAMLES system, our model focuses on the identification of learning content through the learning model based on context and awareness of learners. Using this system, users can easily browse through the course content to adapt as they wish. The learner model is based on the context parameters and learner's demands. The level of knowledge of learners is represented by a set of discrete values corresponding to the results of the tests. Disadvantages of the model represented by discrete values do not fully represent several learner models, especially when they depend on learner's knowledge; the level of knowledge is constantly changing during learners participating in the courses. Therefore in the next version of CAMLES, we used Bayesian Network to represent learner model in order to overcome those limitations.

Recently, Bayesian Network model has been widely used for measuring learner knowledge instead of using vector or concrete value. There are several systems

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applying this model to manage their learner model. SQL Tutor [2] presents domain knowledge in terms of many constraints, which are factors for Bayesian making multiple predications about students. HYDRIVE [3] models student's skill at troubleshooting an aircraft hydraulics system. Bayesian is used to update the student model, using as evidential student factors. In CATs system [4], Bayesian Network used to select new questions for adaptive tests; it was constructed as nodes that measure student's knowledge and gathers evidence with two kinds of links: aggregation relationships among knowledge variables, and relationships among knowledge and evidential variables. MEDIA system [5] managing attitude model, knowledge model are two sub-models of student models. Bayesian is constructed for aggregation and prerequisite relationships.

The rest of this paper is structured as follows. Firstly, we will review related researches on context-aware learning depending on location. In the next section, the factors used in the context of our model to adapt the course content for each learner as well as CAMLES model will be introduced. In the fourth section, we focus on how to apply Bayesian Network to manage learner model of the CAMLES system as well as system prototype implementation. Finally, discussions and conclusions are summarized.

2 Literature Review

Our literature review presents recent context–aware m-learning applications for language learning. Especially, those support students to learn foreign languages. These applications can be classified into two categories: context-aware location-independent learning and context-aware location-dependent learning. Now, we focus on several typical applications:

- TenseITS [6] teaches English language to foreign students through meeting their demands. Learner model is designed based on four context factors: location, interruption/distraction, concentration and available time. Appropriate learning materials for different learners are selected based on the information represented in learner model.
- CAMCLL [7], context-aware location-independent learning, teaches Chinese to the students whose language levels are not enough to make conversations in Chinese by supporting appropriate sentences to different learners based on contexts. The CAMCLL context includes time, location, activities and learner levels. Adaptive engine of it is based on ontology and rule-based matching.
- LOCH [8], context-aware location-dependent learning, supports students to learn Japanese while involving in real time situations. By monitoring the positions of the learners, teachers can establish the communication with the students and guide them. The context factor in LOCH system is location.

3 Context Aware Mobile Learning Architecture

In order to select personalized mobile learning materials based on the context as well as learner's preferences, we propose architecture with their layers described in Figure 1.

It includes several layers: Context-awareness detection layer, Database layer, and Adaptation layer. The following brief describe the system components.

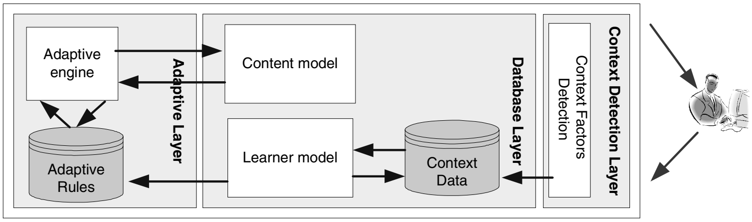

Fig. 1. Context Aware Mobile Learning Architecture

3.1 Context-Awareness Detection Layer

The function of the context-awareness detection layer is to identify the context factors such as location, time interval, manner of learning and learner's knowledge that have impact on selecting adapted learning materials for different learners The core of this layer includes main functions: i) Detecting location, ii) Collecting time interval request, iii) Collecting the learner's preferences, iv) Testing for learner's knowledge evaluation.

3.2 Database Layer

Database layer consists of context data, content data, learner's profile and test. Context information includes two categories: learner's request and learner knowledge. The first category is the information obtained from the learner's request such as location, interval of time to learn and concentration. These factors require the learners to fill in before they participate in the course. In this model, we define location as a place where learners use mobile devices to take part in the course. Each location is described by a corresponding discrete value such as (Bus Terminal: 1; Restaurant: 2; Outing: 3; Campus: 4; and Home: 5). This represents the factors that have impact on learning activities such as concentration level, the frequency interruption as well as available time to learn. The lower value indicates that the location affecting context factors is higher, whereas the higher value indicates that impact is lower. Interval of time is available time that the learner will spend learning. Similarly, we use discrete values to identify the level of concentration. The learner can choose one of parameters before participating in the course. The concentration parameter is designed to determine the learners' requirements about concentration on learning while student uses mobile devices to browse the course. Three concentration levels are low, medium and high.

The second category is learner's knowledge that is assumed to be a context factor because of knowledge level variation. In our model, learner knowledge is evaluated in several ways. The first one is by several test questions at the first time they participate in the course. The second way occurs when learners finish one topic; the system requires them to take several questions in order to test their knowledge on this topic. The third way is that learner can change their knowledge levels as desired. We use concept-based domain to describe the course content. It is represent a graph with node denotes concept, and vertex denotes relationship among each concepts. The difference in the use of concepts in the studies is the determination of the unit of measurement concepts. Depending on the content areas, different applications and design point of view, measure different concepts such as knowledge units [9], the rules [10], and constraint [2]. In our model, we propose concept as definitions below:

Definition 1: *The concept is a basic unit to present a specific content.*

In the content model, the concept is understood as the smallest unit of course content, in other words it would not exist as a C_i concept which is a part of C_j concept. To determine the relationship between these concepts, we propose the prerequisite concept definition as follows.

Definition 2: *Prerequisite concepts: C_i concept is called the concept's prerequisite of C_j concepts when to understand the C_j concepts necessary to understand the concept C_i (Denotes is: $C_i \rightarrow C_j$).*

Defining prerequisite describe relations between concepts in the model, we only consider the prerequisite relationships between concepts rather than considering the relationship component is used in some models [11, 12], because in our model composition concept is considered the smallest unit. To show information about the level of knowledge of learners, we build a model based on the overlay model. We use the probability values to quantify the level of understanding for the learner's concept.

3.3 Adaptation Layer

Adaptation layer includes some functions designed to adapt learning materials for each learner. Based on the results of test as well as learner’s background, Learner’s knowledge evaluating component used to identify how learner’s knowledge level is. The heart of this layer, learning resource selection component, is used to select appropriate adaptive learning content for each learners according to their learner modeling. We designed several rules to choose learning resources from content model as traveling of tree nodes. The child node describes detailed information about parent node. Learning material is adapted to different learners in two ways. The first way is that when learner selects one topic from the suggested list, the content belonging to this topic is adapted based on learner model of different learners. The second way occurs when the learners finish a test, the system recommends one or more topics that students need to learn.

The Rules we used to select learning resources in this model is if – then rules [1]. Defended on learner model, the adaptive rules include three elements such as height of tree, number of topic and number of test question. The height of tree informs that how information detail is. The number of topic denotes the number of child nodes or sub topics of determine topics. Having several sub topics, the number of topics will decide how many topics are supplied to different learners. Similarly, the number of test questions denotes how many test questions will be required to take after different learners browsing the definite topics.

4 How to Apply Bayesian Network to Manage Learner Model

4.1 Probability Values Represent the Knowledge Level of Learners

In the model, with each concept we use two state variables to quantify the level of knowledge of learners for the reasons as follows: i) using the overlay model needs the variable to store value that indicated level of knowledge to the learner's concept; ii) Assess the level of knowledge of learners needed for quantify concepts: The notion that knowledge of learners; respectively level learners do not understand that concept. In the model, we represent each level through a state.

For each concept C, the two state variables are used to represent their understanding of learners to this. It is:

- Not_acquired: represents that knowledge level of learner does not acquire the concept.
- Acquired: represents that knowledge level of learner acquires the concept.

For each concept C, p (C = not_acquired), p (C = acquired) denotes the probability value representing that the state may be not acquired or acquired the concept C. It has: p(C = not_acquired) + p(C = acquired) = 1.

Bayesian Network applications [13] quantify the level of understanding for the learner's concept. From the general formula for the probability distribution, we determined the quantitative formula of the level of knowledge for C_n concept through the following propositions:

The C_1, C_2,..., C_{n-1} concepts are the prerequisite concepts of C_n concept. Meanwhile the value of quantitative level of knowledge of learners to the C_n concept is determined by the following formula:

$$P(C_n | C_{n-1},\ldots,C_2,C_1) = P(C_n | Pa(C_n)) \text{ with } Pa(C_n) \subseteq \{ C_{n-1},\ldots,C_2,C_1\} \quad (1)$$

4.2 How to Evaluate Learner’s Knowledge

This section presents the research results, new contributions in building adaptive mechanism to adapt courses to meet learner’s demands to select the concept suggests that learners need to learn during the course participants.

To quantify the level of knowledge, we build a Bayesian network model, with the inference mechanism to quantify the level of understanding of each concept of learners. The adaptive rules [14] are applied on the basis of quantitative values to select the concepts that learners need to learn.

After constructing Bayesian Network, we carry out reasoning to quantify the level of understanding concepts of learner. The goal of this step is to quantify the knowledge level of learners for each concept in each stage of learning for the course, as a basis for adaptive content selection to suit each learner. We use two strategies of quantitative reasoning: i) *Diagnostic reasoning*: This mechanism is used in cases where learners do not understand a C concept, to determine the value of the probability of the learner’s understand prerequisite concepts of C concept. ii) *Predictive reasoning*: This mechanism is used in cases to determine the quantitative value of the probability of understanding level of the C concept when the probability that the value of the degree of understanding level of prerequisite concepts is known.

Rules based to select concepts that learners need to learn. This step, we shall select concepts to guide the learners need to learn as well as point out the concepts that can be ignored. Learners are allowed to ignore concepts to learn if the learner has to understand the concepts. The quantitative value of the probability level of understanding of the learners has been identified in the previous step, which is a basis to determine the learners who understand the concept. The problem is how much the learners are deemed to have understood the concept with the probability value. In the study by Millan [4], Wei [15] considered if the learner understands the concept of the probability, values are from 0.7 to 1, if he/she does not understand the concept, the probability values are from 0 to 0.3, and unspecified when the value is about 0.3 to 0.7. Our opinion, the choice of threshold in this model is not good because with the identification of such threshold, the concepts are considered equal. However, the concept of the course content has different level of difficulty. Therefore, assessment of their understanding of learners needs to consider the level of concepts.

5 System Prototype Implementation

We implemented CAMLES prototype based on J2ME technology. In order to use CAMLES, the learners need to download and install applications alone in their mobile phones. At this stage, we develop content model which consists of five main topics: Adjectives and Adverbs, Pronouns, Questions, Noun Phrases and Commands. Those are considered parent topics for the entire contents of the system. Under each topic, there will be corresponding child topic, for example, the child of Adjectives and Adverbs topic are Adjectives, Adverbs. The learner inputs context parameters via mobile interface. The topic content was adapted to him. Finishing this topic, the system suggests some question tests to evaluate learner's knowledge about topic and shows the test results as well as recommend in the next screen.

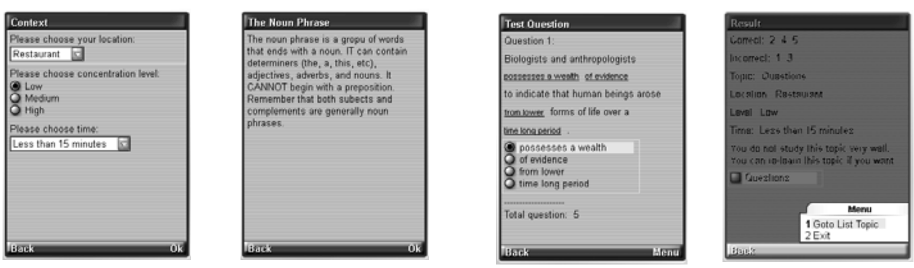

Fig. 2. Learner inputs context parameters and adaptive content showed (two left pictures) as well as Test questions for evaluating learner's knowledge (two right pictures)

To examine our experimentation, we designed a questionnaire includes six questions to survey 35 students who used CAMLES system with their mobile phone which supports GPRS or 3G to connect to Internet. In order to evaluate our system, students check to one of from 1 to 5 values that 1 was the lowest and 5 was the highest. We classify student into three categories: group one includes students who never taken the TOEFL test before, group two contain students who have never taken TOEFL test and get below 450 score (paper test), and group three are students have get above 500 score.

According to Question 1 and Question 2, the students who are satisfied with system would like to use the system again. Question 5 was used to survey learners who choose the context which was/is true to them or not. As you see, in Group 1 result, students who never take the TOEFL test before are interested in our system. However, Average score of Question 5 is 3.0, which shows that they often choose the context which is not true as they in. For example, they can choose Restaurant location while they in class.

6 Discussions

Our target users are graduate students who intend to take TOEFL test. However, this approach can be applied to general learners to study English as a foreign language. Our model, context-aware location-dependent learning, adapts learning content according to context as well as learner's knowledge background. To find interests in our system, we compare it with early systems.

In TenseITS [6] learner's knowledge parameter only calculate at current stage, so if the learner, from second time, backs to the system with the same context factors such as inputted previously, the adaptive contents are similar. In our model, learner's knowledge background is stored and is evaluated after the students finish the topic. The results are basic for calculating learner model value for next time learners use system. The CAMLL [7] is also based on learner level to adapt suitable sentences; however, how the learner level updates learning progress has not been specified.

7 Conclusions

This paper has introduced new version of CAMLES, a context aware mobile learning for supporting Vietnamese students to learn English language to prepare for TOEFL test as well as describe how to apply Bayesian Network to manage overlay learner model. It adapts learning materials according to the learner's knowledge as well as their location, their available time, their concentration. At this stage, our learner model is still not distinct for all context cases. Therefore, there are several different contexts which have the same value in learner's model. In the future work, we will consider refining the content model as well as adaptive engine in order to match the learner's requests. One notable problem is how to fragment content to display in accordance with the size of the mobile phone, which also needed to be considered.

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References

1. Nguyen, V.A., Pham, V.C., Ho, S.D.: A Context-Aware Mobile Learning adaptive System for Supporting Foreigner Learning English. In: Proceedings of IEEE-RIVF International Conference on Computing and Telecommunication Technologies (2010)
2. Mitrovic, A.: An Intelligent SQL Tutor on the Web. International Journal of Artificial Intelligence in Education 13, 173–197 (2003)
3. Mislevy, R., Gitomer, D.H.: The Role of Probability-Based Inference in an Intelligent Tutoring System. User Modeling and User-Adapted Interaction 5, 253–282 (1996)
4. Millan, E., Perlrez-De-La-Cruz, J.L.: A Bayesian Diagnostic Algorithm for Student Modeling and Its Evaluation. User Modeling and User Adapted Interaction 12, 281–330 (2002)
5. Carmona, C., Millán, E., Pérez-de-la-Cruz, J.-L., Trella, M., Conejo, R.: Introducing Prerequisite Relations in a Multi-layered Bayesian Student Model. In: Ardissono, L., Brna, P., Mitrović, A. (eds.) UM 2005. LNCS (LNAI), vol. 3538, pp. 347–356. Springer, Heidelberg (2005)
6. Cui, Y., Bull, S.: Context and Learner Modeling for the Mobile Foreign Language Learner. Science Direct System 33 (2005)
7. Al Mekhlafi, K., Hu, X., Zheng, Z.: An Approach to Context-aware Mobile Chinese Language Learning for Foreign Students. In: Proceedings of Eighth International Conference on Mobile Business (2009)
8. Otaga, R.J., Saito, A., H.N., Yin, N.A., Yano, C., Oishi, Y., Ueda, Y.: LOCH: Supporting Informal Language Learning Outside the Classroom with Handhelds. In: Proceedings of the 2005 IEEE International Workshop on Wireless and Mobile Technologies (2005)
9. Oberlander, J., O'Donell, M., Mellish, C., Knott, A.: Conversation in the Museum: Experiments in Dynamic Hypermedia with the Intelligent Labeling Explorer. The New Review of Multimedia and Hypermedia 4, 11–32 (1998)
10. Ritter, S.: PAT Online: A Model-Tracing Tutor on the World Wide Web. In: Proceedings of 8th World Conference of Artificial Intelligence in Education, pp. 11–17 (1997)
11. Bra, P.D., Ruiter, J.P.: AHA! Adaptive Hypermedia for All. In: Proceedings of World Conference of the WWW and Internet AACE, pp. 262–268 (2001)
12. Trella, M., Carmona, C., Conejo, R.: MEDEA: an Open Service-Based Learning Platform for Developing Intelligent Educational System for the Web. In: Proceedings of Workshop on Adaptive Systems for Web-based Education at 12th International Conference and Artificial Intelligence in Education (2005)
13. Pearl, J.: Probabilistic Reasoning in Expert Systems: Networks of Plausible Inference. Morgan Kaufman Publishers, Inc., San Francisco (1998)
14. Nguyen, V.A., Nguyen, V.H., Ho, S.D.: Developing Adaptive Hypermedia System Based on Learning Design Level B with Rules for Adaptive Learning Activities. Journal of Natural Science, Vietnam Nation University 25(1), 1–12 (2009)
15. Wei, F., Blank, G.D.: Student Modeling with Atomic Bayesian Networks. In: Ikeda, M., Ashley, K.D., Chan, T.-W. (eds.) ITS 2006. LNCS, vol. 4053, pp. 491–502. Springer, Heidelberg (2006)

A Walk-Rally Support System Using Two-Dimensional Codes and Mobilephones

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Abstract. "Walk-Rally" (WR), an orienteering-like recreation game, is common especially in Japan. Plenty of trials to combine WR and educational activity are shown by some educators. We developed a WR support system based on the mobilephones having a function of two-dimensional (2D) code reader. Our system can be adapted to both of following two cases: 1) WR Participants read 2D codes placed at each check points with their mobilephones. 2) Human checkers having a mobilephone at each check points read a 2D code which is printed on each WR participant's ID tag. We tested our system with two events whose populations were 100~600. During these events our system had been working successfully.

Keywords: Walk-Rally, Two-Dimensional Code, Mobilephone.

1 Introduction

A "Walk-Rally" (WR) is a kind of orienteering-like recreation game, and is common in Japan. The difference between WR and an orienteering is the fact that WR is not a speed race like orienteering, but a "Rally" that requires a prescribed traveling time span similarly to the motorsport rally. In addition, usually WR participants are assigned some tasks at each check point. The traveling time span of WR includes the time to do the tasks. A typical example of such task is a quiz like: "What flower can you see around this check point?". Generally the planners of the WR prepare these tasks not to be solved unless the participants actually reach at the check points.

WR is often held by some schools as a part of their curriculum. There are many examples to adopt WR to an educational activity [1,2]. WR provides very good opportunities for students to learn about the nature or the region. However, during the conventional (with paper and pencil) WR in school, it is difficult for teachers to keep track of each student's position constantly. This situation will cause anxiety among the teachers.

We developed a system to realize realtime confirmation of each WR participant's state by using mobilephones. The essential feature of our system is a combination of two-dimensional (2D) codes and web technology. The organizers of WR can monitor the present status of each participant with their web browsers. Our system requires mobilephones having a function to read "QR code", which has widely spread over Japan. Almost all of mobilephones in Japan have a function of QR code reader. We briefly review about the QR code in the following section.

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2 QR Code

QR code originated from Japanese company "DENSO-WAVE Incorporated" in 1994 [3]. This is treated as a two-dimensional extension of one-dimensional "Bar-code". In fact, its capacity is up to several hundred times larger than ordinary bar-code. Since QR code pattern realizes remarkable readability, it becomes a de facto standard of 2D codes in Japan. There are some applications of QR code to the education [4]. The algorism to render QR code is open to the public therefore many free QR code translation software/services are provided on the web. Google Chart API is one of such services. Fig.1 shows an example of QR code, which is translated from the string "http://www.cirkit.jp/" by Google Chart API [5].

Fig. 1. An example of QR code Translation

3 Outline of Our System

Our system has following two operation modes: 1) Using QR code as an identification of check point (CP), 2) Using QR code as an ID tag of each WR participant. Firstly we consider the former case.

3.1 "QR Code CP" Mode

Fig.2 shows the outline of "QR code CP" case. In this case the QR code, which translate the URL including ID number corresponding to each CP, is printed on the sheet and placed at all CPs. The ID number in the URL is an encrypted long string so as to prevent the cheating of participants.

WR participants must have their mobilephones having QRcode reader function. At the first time, all of the participants have to submit the UTN (Unique Terminal Number), which is assigned to each mobilephone by the manufacturer, to the web server in order to identify themselves. This will be automatically completed if a participant accesses the top page of the website of our system. When WR participant reaches at the CP, he/she reads the code with their mobilephone. If the code is successfully read, the corresponding URL appears in the screen of the mobilephone. Then, the participant accesses the URL by pressing a button. At that time, UTN is sent to the web server with ordinary HTTP request. The web server sends a quiz to the participant's mobilephone. When the participant answers the quiz correctly, his/her task at the CP is completed.

In this case it is necessary for participants to have their mobilephones. However, in general, young children such as elementary school students do not have their own mobilephone. Taking into account such situations, we should consider the case that the QR code is used for an identification of the participants (not CP).

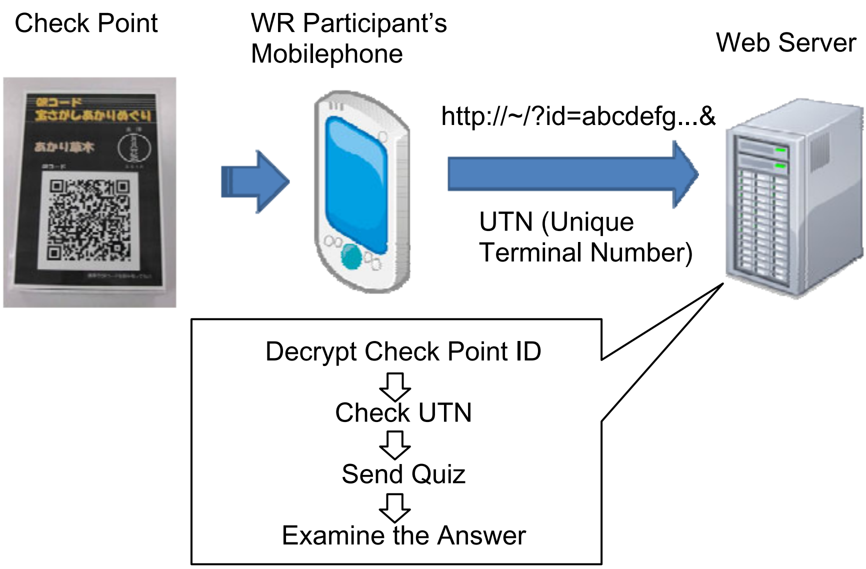


Fig. 2. Outline of "QR code CP" Case

3.2 "QR Code Tag" Mode

Fig.3 shows the outline of "QR code Tag" case. Obviously, this is a reverse version of "QR code CP" case. WR participants have their own QR code ID tags. The human checker having their own mobilephone waits participants at each CP. The UTN of

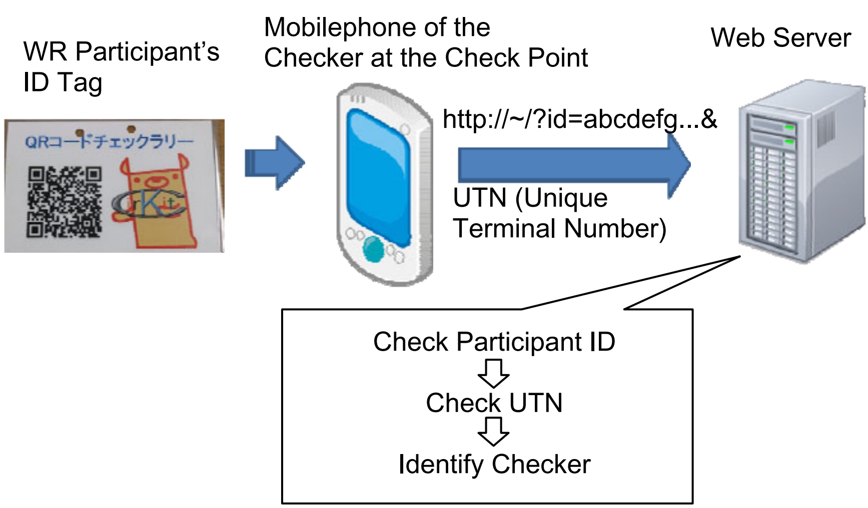
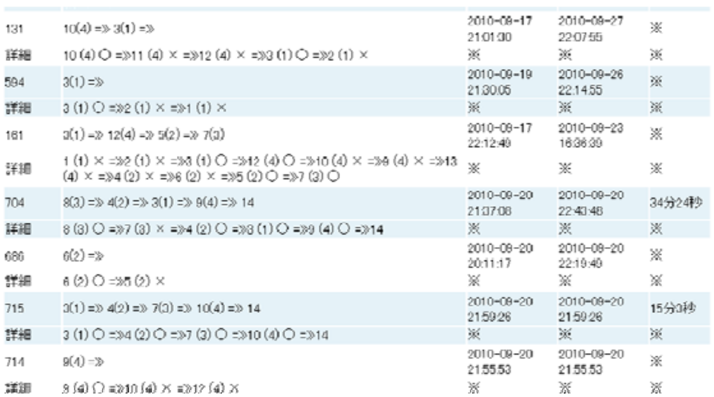


Fig. 3. Outline of "QR code Tag" Case

checker's mobilephone is registered to the server before starting the WR. When the participant reaches at the CP, the checker reads the QR code of participant's ID tag, and access the URL displayed in the mobilephone screen. In this case the tasks at each CP are assigned by a written quiz, or announced by the checker.

3.3 Administration Page

In both cases the web server logs WR activities of all participants. The WR organaizer can see these activities at the administration page of our system (Fig.4). This page is reloaded automatically at preset time intervals.



131	10(4) =» 3(1) =»	2010-09-17 21:01:30	2010-09-27 22:07:55	※
詳細	10 (4) ○ =»11 (4) × =»12 (4) × =»3 (1) ○ =»2 (1) ×	※	※	※
594	3(1) =»	2010-09-19 21:30:05	2010-09-26 22:14:55	※
詳細	3 (1) ○ =»2 (1) × =»1 (1) ×	※	※	※
161	3(1) =» 12(4) =» 5(2) =» 7(3)	2010-09-17 22:12:49	2010-09-23 16:36:39	※
詳細	1 (1) × =»2 (1) × =»3 (1) ○ =»12 (4) ○ =»10 (4) × =»9 (4) × =»13 (4) × =»4 (2) × =»6 (2) × =»5 (2) ○ =»7 (3) ○	※	※	※
704	8(3) =» 4(2) =» 3(1) =» 9(4) =» 14	2010-09-20 21:37:08	2010-09-20 22:43:48	34分24秒
詳細	8 (3) ○ =»7 (3) × =»4 (2) ○ =»3 (1) ○ =»9 (4) ○ =»14	※	※	※
686	6(2) =»	2010-09-20 20:11:17	2010-09-20 22:19:49	※
詳細	6 (2) ○ =»5 (2) ×	※	※	※
715	3(1) =» 4(2) =» 7(3) =» 10(4) =» 14	2010-09-20 21:59:26	2010-09-20 21:59:26	15分3秒
詳細	3 (1) ○ =»4 (2) ○ =»7 (3) ○ =»10 (4) ○ =»14	※	※	※
714	9(4) =»	2010-09-20 21:55:53	2010-09-20 21:55:53	※
詳細	9 (4) ○ =»10 (4) × =»12 (4) ×	※	※	※

Fig. 4. Screenshot of Administration Page

The source code of server program is written in PHP. It also requires a backend database. Our server is a typical LAMP(Linux, Apache, MySQL and PHP) environment.

4 Practical Operation Examples

4.1 "Tsukimi Kouro"

Our system was firstly tested at the event named "Tsukimi Kouro" (means "fantastic illuminations on the road under the moonlight"), which was held during September 17-20, 2010. "Tsukimi Kouro" is one of the educational projects in Kanazawa Institute of Technology [6]. It is performed by the project team that consists of students and professors belong to the College of Environmental Engineering and Architecture in Kanazawa Institute of Technology. During the term of the event, various lighting objects are placed at central park of Kanazawa-City. These objects turn on the light in the evening, and then central park becomes full of fantastic illuminations.Fig.5-a shows an example of "Tsukimi Kouro" objects. All these objects are hand made by the members of "Tsukimi Kouro" project team.

To make this event more enjoyable, we planned to hold a WR collaborated with "Tsukimi Kouro". We chose "QR code CP" operation mode of our system, and selected 16 points to place QR code sheet in front of the groups of lighting objects. However, at that time we faced a critical problem. Since "Tsukimi Kouro" is a night event, each CP must be too dark so that the participant cannot read QR code. This difficulty was solved by introducing "Lightbox CP", which can illuminate QR pattern with transmitted lighting (Fig.5-b).

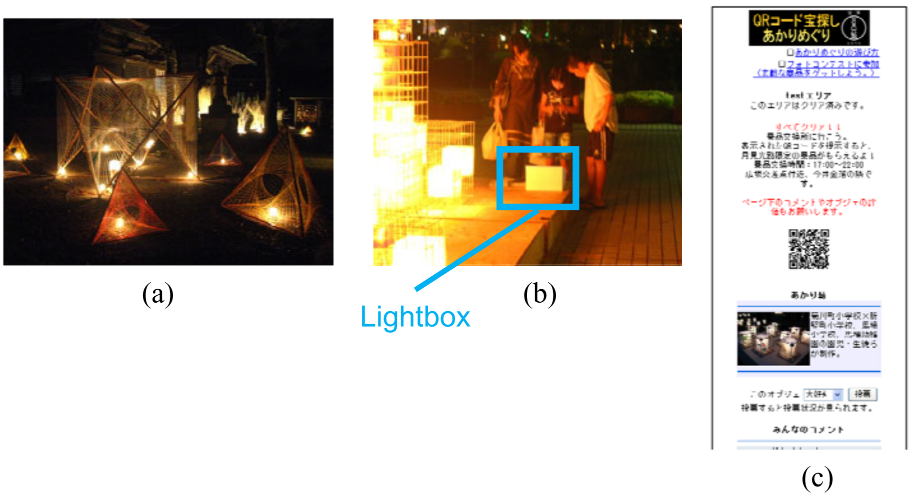


Fig. 5. "Tsukimi Kouro" Event

The initial registration process of "Tsukimi Kouro" WR is started when a QR code at any of the CPs is read by a mobilephone. When the owner of the mobilephone accesses the URL subsequently appeared in the mobilephone screen, the mobilephone owner is automatically registered as the participant of WR. We did not take into account the visiting order of CPs and traveling time of the participant. The task for participants is to find a "Treasure". We divided the whole area of central park into four segments. Each of the segment contains 2~8 CPs. There is only one "Treasure" CP par one segment. The participant's "Treasure" CP is different from each other. Therefore the participants must visit CPs in the segment one by one until they get the "Treasure". The participants can send comments and vote for the object at the CP via their mobilephones. When participants complete all their treasures, a special QR code appears in their mobilephone screen (Fig.5-c) with an instruction to go to the WR office. In WR office the checker read the QR code displayed in the participant's mobilephone to make sure the completion, and then the checker gives a souvenir to the participant.

During those four days, total number of registered people was 694 including 186 participants completed all treasures.

4.2 “Camellia Festival”

“Camellia Festival” was held on October 16, 2010 at “Camellia”, a central community center of Nonoichi-Town (http://e-camellia.jp). Camellia Festival was the 5th anniversary event of the foundation of Camellia, contained live concerts, recreational games and star watching. WR supported by our system was also a part of those contents. It was expected that the major participants of the WR are children or low-teen agers. However, especially in Nonoichi-Town, all of the elementary/junior high school students are prohibited to have their mobilephones. Hence we had to take “QR code Tag” operation mode for our system.

We made 100 of QR code tag (Fig.6) and distributed them to each participant. The mission of the participants is searching three checkers who are somewhere on Camellia premises. After completion of all three checkers, the participant can draw a lottery at WR office and receive a souvenir. At that time we ask the participants to fill the questionnaire.

Unexpectedly, total number of the participants was 126 so that we should urgently make spear tags. The result of questionnaire is shown in Fig.7. The participants tend to feel much fun when they are searching the checkers.

Fig. 6. An Example of QR code Tag

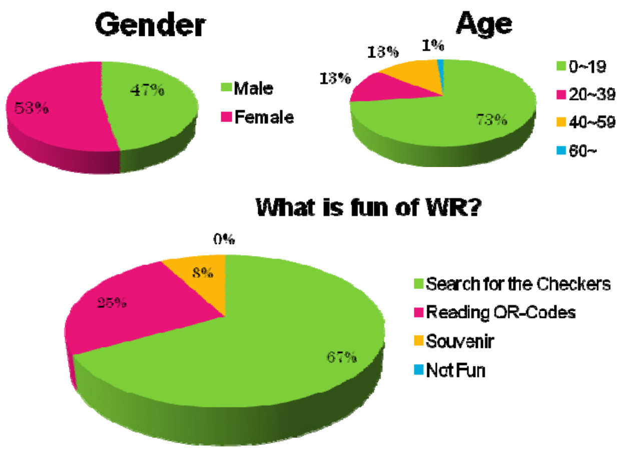


Fig. 7. Results of Questionnaire

5 Conclusion and Further Remarks

In this work we constructed a WR support system using QR codes and mobilephones. Our system has two operation modes such as “QR code CP” and “QR code Tag”. We tested our system in both case practically and got successful results respectively.

In Japan, all of the 3G mobilephones have a GPS function. By introducing GPS, the function variety of our system can be extended more. Currently our system requires some human checkers for the scenario “QR code Tag”. However, such human checkers might not be needed if we use USB QR code readers connected to the mobile PCs.

Our system has not been used with educational activities yet. However, our system is convincing us of its enough potentiality for educational use. The application of our system to educational activities will be our future subject.

References

1. Oku, T., Kanki, K.: Research on the Recognition of the Place of the Elementary School Child by the Walk Rally: The Case Study of Kada Area, Wakayama City. Study Reports of Kinki-division of Architectural Institute of Japan 38, 525–528 (1998)
2. Shimizu, M., Sugawara, M., Sato, R., Ikota, A., Kosugi, T.: The Practice of WALK RALLY education for diabetic patients in our hospital. Journal of Hokkaido Physical Therapy 21, 105–110 (2004)
3. DENSO-WAVE Incorporated, `http://www.qrcode.com/index-e.html`
4. Chaisatien, P., Akahori, K.: Introducing QR code in Classroom Management and Communication via Mobile Phone Application System. In: Pearson, E., Bohman, P. (eds.) Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications 2006, pp. 2181–2187. AACE, Chesapeake (2006)
5. Google Chart API, `http://chart.apis.google.com/chart?chs=150x150&cht=qr&chl=http://www.cirkit.jp/`
6. Higashide, E., Itou, S., Amano, T., Takechi, Y., Soeno, K.: Lighting event in the center areas of Kanazawa city: Tsukimi-kouro. Proceedings of Annual Meeting of The Illuminating Engineering Institute of Japan 38, 214 (2005)

A Service Platform for Logging and Analyzing Mobile User Behaviors

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Abstract. Quantitative analysis of user behavior calls for automated collection of large amount of log data over time. In this paper, we present a service platform for logging and analyzing mobile user behaviors. We have implemented a log collection service which records all user operations on the mobile unit. The collected data are transmitted to a remote server based on an energy-aware schedule. By providing a simple web-based interface, researchers can selectively retrieve the log according to the subject of interest. We illustrate the functionalities of the proposed service platform by several sampled logs.

Keywords: mobile devices, user log analysis, mobile user behavior.

1 Introduction

The rapid growth of App platforms coupled with the widespread installation of communication networks have contributed to the proliferation of smart mobile devices all over the globe. In the past few years we have witnessed significant increase in the shipments of smart phones following the introduction of Android and iOS operating systems. The versatile functionalities provided by such devices have fundamentally changed the way people use mobile phones. Voice communication is no longer the dominant function on modern mobile devices. Instead, leisure activities such as gaming, music, photography and wireless services such as web access, location-based service (LBS), and mobile social networks are becoming increasingly popular. New modes of services are being exploited to further take advantage of the new and constantly evolving mobile platforms. It is therefore of great interest to investigate the long-term usage patterns on these devices to study the user behavior and understand their needs to help design a better user experience.

Traditionally, experiments are carefully designed and conducted under controlled environments with specific parameters to examine or identify the influence of certain variables. The operation process is documented either in paper-and-pencil format or using audio-visual recording devices. Because participants are constrained spatially and temporally in a laboratory setting, their behaviors may differ from everyday life. Moreover, unfamiliarity with the environment as well as the equipments may affect the user performance in specific tasks. Knowing that an observer is watching can

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sometimes be an annoyance. Apparently, traditional approaches have their limitations when it comes to the study of long term daily user behavior. It is necessary to develop new methodologies to record and interpret user logs on smartphones if we intend to conduct experiments to understand user behavior and assess user preference over a longer period of time.

Many applications on the smart phone do not function independently. They require internet connection to upload and access information, including simple file exchange, social games, or photo sharing. A novel or casual user may take some time to get familiar with the user interface. It is therefore difficult to collect meaningful usage patterns in the laboratory given the time constraint. Additionally, modern smart phones integrate diverse functions such as entertainment, photography, or calendar which may be activated in different contexts. The time or location data, which are considered irrelevant in a lab setting, become an integral part of the user log in a long-term field study.

Many mobile platforms have built-in social network service. With pervasive availability of wireless networks, social activities are no longer constrained by access to computers. Interactions among people now take a new assortment of forms, extending from basic voice communication to text messaging, multimedia sharing and position tracking. These interactions may, in turn, affect the collective behavior of a certain user group. Investigation of the dynamics and characteristics of these mobile social networks also calls for the development of new and powerful log collection and analysis tools.

Prior to the introduction of Android OS, almost all mobile operation systems are proprietary and leave very little room for modification. It is thus difficult to implement a 'monitoring' application to keep track of user operation due to security concerns. The uprise of Android has resolved this issue since Android is an open-source platform that offers great flexibility in modifying and supplementing extra functions for the system. This research takes advantage of the openness of Android OS to develop a log collection service that executes in the background and records detailed user operation in a database. The user log will be transferred to a remote server when internet connection is available. The collected data are stored on a remote database to allow researchers to download specific portion of the log for further analysis using a web-based query interface.

The rest of this paper is organized as follows. In Section 2 we briefly review some related work with special emphasis on long-term log collection and analysis. Section 3 presents the log collection service implemented in this research. It consists of two parts: log collector which runs on the device and log monitor which runs on the remote server. Section 4 concludes this paper with a brief conclusion and outlook on future researches.

2 Related Work

The study of mobile user behavior in real-life settings has gained increasing attention recently. In [1], the authors made a long-term observation of user's personal behavior as well as interactions among members of a group using time and location information recorded by Bluetooth devices. More details regarding the user operation can be obtained by running a background log collection program on the mobile device, as reported in [2]. Such log data reveal individual usage patterns on the smartphone, including text messaging, phone calls, photo shooting, game playing or other leisure activities. The log collection service implemented in our research follows a similar approach, except that we have a broader goal, i.e., to provide a shared platform combining hardware resources, software design and user group management so that researchers from different areas of expertise can work together to explore new research issues.

Online game community also has access to a large amount of log data collected in different game sessions. In [3], the authors built a database containing character's profile such as character ID and location through a client-side user interface. By analyzing the relationship between characters and groups (or guilds), they are able to study the evolution of online communities from a social network perspective. A tool named 'Social Dashboard' was designed to monitor the group dynamics in real-time. Although this research focused on online game community, it inspired us to develop a similar web-based log monitoring tool for researchers to have a quick glimpse of the overall status of the collected data to ensure smooth operation of the experiment.

3 The Proposed Log Collection and Analysis Service

This section presents the log collection and analysis platform implemented in this research. We first describe the initial setup of our experiment, namely, the recruit of volunteers and deployment of machines to have a trial-run to get early feedback. We then proceed to elucidate the details of the log collection service, including the data flow, log table format and service policy.

3.1 User Recruiting and Preliminary Study

Quantitative analysis calls for the collection of sufficient samples. However, we need to set up a trial-run to validate the design of our log collection service before launching a larger scale experiment. Toward this goal, we recruit 15 users to participate in the test phase. To facilitate the research of mobile social networks, we expect certain interactions amongst the users. Therefore, some level of acquaintance is assumed when we recruit the volunteers. The participants are not required to be expert users of smart phones, though. We intend to put together a group with a good mix of novice and veteran users so that we can observe more varieties of user behaviors and investigate possible interactions between different types of users.

The main purpose of conducting a preliminary test is to uncover potential pitfalls of the log collection service through the feedback of early adopters. For examples, it was found that many task management applications on Android whose main function is to monitor and manage resources can interfere with the normal execution of our log collection service. This may result in partial loss of data in some cases, and total failure of the background log collection process in other situations. Consequently, we need to modify the priority of the log collection service and implement an auto-restart policy in case of system breakdown. Additionally, transmission of log data consumes power, which is a valuable asset on mobile devices. During the initial test phase, we can set up different criteria to schedule the delivery of log data and observe the power consumption status to ensure that the logging service will not generate adverse effects on typical mobile phone users.

3.2 Log Collection Service

We utilize the functions provided by the Android Location Manager to record the position information. As for system logs, there is no corresponding API to directly access the low-level statistics. Instead, we make use of the 'logcat' tool included in the Android SDK to obtain raw data and then filter the desired portion according to our needs.

3.2.1 Service Dataflow

The log data collected using our service must be stored on the mobile device first. This information will be passed on to a remote server when network connection is available. The overall dataflow is illustrated in Fig 1.

Since all the current participants are college students, they can gain free access to WiFi service while in campus. It is thus guaranteed that the operation logs can be collected without returning the hardware to the laboratory, thereby saving the efforts of researchers. The current approach for data acquisition also causes little interruption and interference to the user so that they can continue to operate the phone in a daily-life setting without constantly worrying about the experiment.

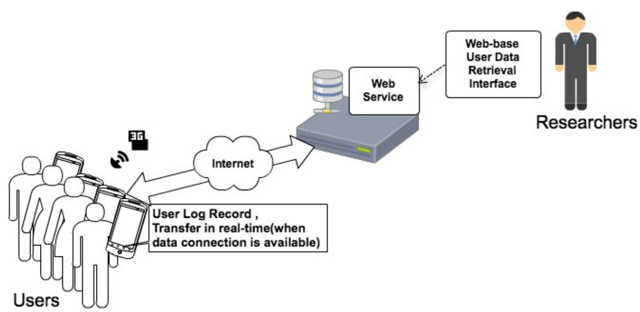


Fig. 1. Service dataflow: user logs are saved locally using SQLite and later transmitted to a remote server when 3G/WiFi connection is available. Researcher can query the database through a web-based interface.

3.2.2 Log Table in the Remote Database

In our current implementation, the local SQLite database keeps track of all system logs generated as a result of user operations, as summarized in Table 1. For example, User_ID and Machine_ID are used to identify the person carrying this device. The Name_App field (encoded as Package Name in Table 1) stores the name of the application activated by the user. External data such as URL are kept in ExternalData (encoded as Data). Finally, the coordinates of user location are stored in Latitude and Longitude fields.

Table 1. Log database

User ID	Machine ID	Time	Package Name	Package Activity	Data	Lat.	Long.
U_0029	Machine_027	10/11/30	com.google.andro	.ConversationListAc	con-	24.980	121.56
U_0029	Machine_027	10/11/30	com.android.mms	.ui.ConversationList	NODATA	24.980	121.56
U_0029	Machine_027	10/11/30	com.android.mms	.ui.ComposeMessag	NODATA	24.980	121.56
U_0029	Machine_027	10/11/30	android	com.android.internal	NODATA	24.980	121.56
U_0029	Machine_027	10/11/30	com.android.htcc	.ContactPhoneMailP	NODATA	24.980	121.56
U_0029	Machine_027	10/11/30	com.android.mms	.ui.ComposeMessag	NODATA	24.980	121.56

3.2.3 Known Limitations of the Log Collection Service

The ability to transfer log data to a remote server in real-time can facilitate instantaneous processing and analysis of user behaviors. However, we also need to be aware of the energy issue since scanning for available access points (AP) and making the connection will consume substantial power. The issue becomes even more critical if precise location is called for because it will require explicit user permission to turn on the GPS service. As reported in [4], GPS module drains a lot of power compared to WiFi or cellular tower ID localization method. To strike a balance between positioning accuracy and power consumption, the default setting is to avoid using GPS unless explicitly requested. In addition, we will adopt a non real-time data transmission policy. Such a policy can effectively limit the frequency of making connection to the remote database and prevent continuous transmission of small, fragmented data. The risk associated with this mechanism is partial loss of information if the user decides to restore the phone to factory settings before the latest logs have been transmitted. When this happens, we can also track the machine based on prior activity statistics.

3.3 Log Monitor and Query Interface

As stated previously, all log data generated as a result of user operation are stored in a central repository so that researchers can retrieve certain section of the data according to their specific research interests. Researchers who are interested in investigating the dynamics of social behaviors will need to define a set of terms containing all social networking activities and retrieve data accordingly. Since the log database is updated incessantly, the proposed platform provides a convenient web-based user interface for registered researchers to quickly browse and query the content, as elucidated in the following.

3.3.1 Log Charting Service

The amount of data collected using the user logging service is large and continuously expanding. Presenting a large table containing many detailed items is just overwhelming and not very helpful. The log charting service (based on Google Chart) is implemented to assist the researchers to get a quick overview of the log data without much analysis. For example, it is easy to identify the most active users from the user activity chart, as depicted in Fig 2. It is also straightforward to find out which type of application is most often used by a specific user, as illustrated in Fig 3. These statistics can be exported in CVS format for further analysis.

Fig. 2. User activity chart (top: last 24-hour period, bottom: the whole experiment period)

Fig. 3. Charting the types of application run by a specific user

3.3.2 Log Query Service

In-depth investigation of specific user behavior requires the collection and analysis of certain subset of the log data filtered by user profile, operation time, or activity type. The log query service is developed to supply custom-tailored information to researchers. It features a simple web-based interface in which researchers can input some search criteria, such as time interval, activity type, etc., to retrieve certain portions of the log data. When location data is involved, we also present a map (using Google Map API) to indicate the corresponding location, as shown in Fig 4.

3.3.3 Real-Time Log Monitor

User behavior cannot be explained using a single log item. In the past, three different levels of user behavior analysis have been identified, namely, activity, action, and operation [5] An activity usually consists of a sequence of actions and is more related to the motivation behind. An action is a logical unit with a clear goal, and an operation is the most fundamental physical unit. From the researcher's perspective, higher levels of description such as activity or action are of interest. However, a log item can only show us the operations performed. A sequence of logs will constitute higher-level events. Therefore, we need to establish the mapping between an event and its corresponding log sequence. This is achieved by the real-time log monitor service in which the collected logs are listed instantly on a web page in synchronization with user operation, as illustrated in Fig 5.

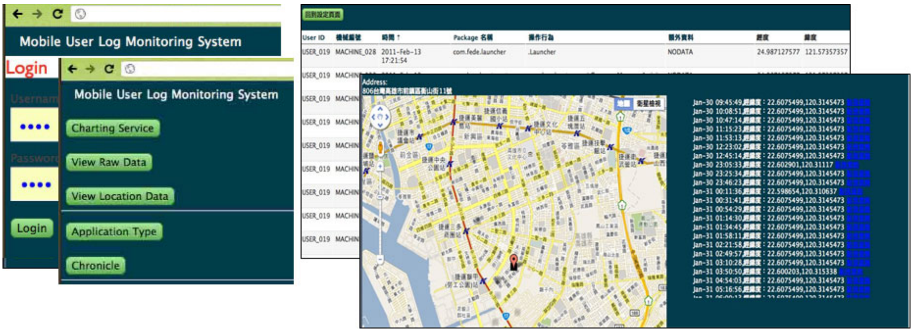
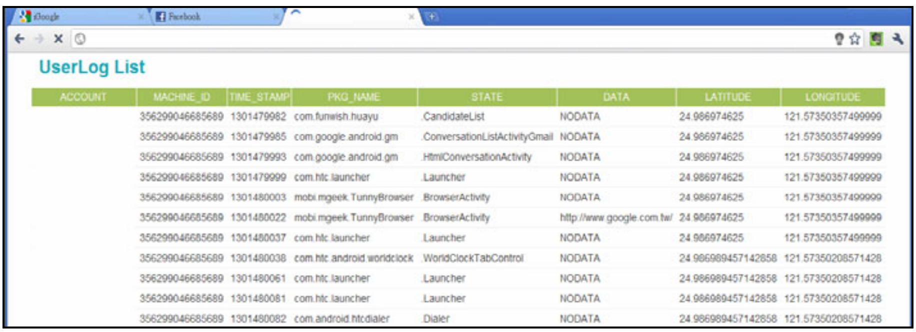


Fig. 4. (Left) Log query interface (Right) Returned data



UserLog List

ACCOUNT	MACHINE_ID	TIME_STAMP	PKG_NAME	STATE	DATA	LATITUDE	LONGITUDE
	356299046685689	1301479982	com.funwish.huayu	.CandidateList	NODATA	24.986974625	121.5735035749999
	356299046685689	1301479985	com.google.android.gm	.ConversationListActivityGmail	NODATA	24.986974625	121.5735035749999
	356299046685689	1301479993	com.google.android.gm	.HtmlConversationActivity	NODATA	24.986974625	121.5735035749999
	356299046685689	1301479999	com.htc.launcher	.Launcher	NODATA	24.986974625	121.5735035749999
	356299046685689	1301480003	mobi.mgeek.TunnyBrowser	.BrowserActivity	NODATA	24.986974625	121.5735035749999
	356299046685689	1301480022	mobi.mgeek.TunnyBrowser	.BrowserActivity	http://www.google.com.tw/	24.986974625	121.5735035749999
	356299046685689	1301480037	com.htc.launcher	.Launcher	NODATA	24.986974625	121.5735035749999
	356299046685689	1301480038	com.htc.android.worldclock	.WorldClockTabControl	NODATA	24.986989457142858	121.57350208571428
	356299046685689	1301480061	com.htc.launcher	.Launcher	NODATA	24.986989457142858	121.57350208571428
	356299046685689	1301480081	com.htc.launcher	.Launcher	NODATA	24.986989457142858	121.57350208571428
	356299046685689	1301480082	com.android.htcdialer	.Dialer	NODATA	24.986989457142858	121.57350208571428

Fig. 5. Real-time Log Monitor

4 Conclusion and Future Work

We have developed a service platform for logging and analyzing mobile user behaviors in this research. Our main objective is to complement existing practices such as survey and interview with automated process to facilitate the gathering of objective measures, namely, the user logs to understand and interpret user behavior. The log collection service is executed in the background to cause minimum interference to the user. As a result, long-term daily-life experience can be investigated. The three tools: log charting service, log query service and real-time log monitor work together to supply customized data in an effortlessly manner.

The proposed service platform can be used to gather logs that are relevant to e-learning or education. For example, there exist several e-book reader applications on the Android platform. Using the log collector, we can record and analyze usage patterns to understand reading behaviors and user preferences as well as evaluate the efficacy of the interface design.

The platform is designed to support concurrent experimentations. However, as the number of experiments increases, we need to look out for possible conflicts in the experiment design. Otherwise the log data may be meddled to such an extent that no sensible conclusion can be drawn from the observation. Moreover, we may need to design better scheduling policy for the delivery of log data to preserve power consumption on the mobile device. Finally, we will solicit feedback from researchers who have used our experimental platform to further enhance the quality of the service.

References

1. Eagle, N., Pentland, A.: Reality mining: sensing complex social systems. Personal Ubiquitous Comput. 10, 255–268 (2006)
2. Kärkkäinen, T., Vaittinen, T., Väänänen-Vainio-Mattila, K.: I don't mind being logged, but want to remain in control: a field study of mobile activity and context logging. In: Proceedings of the 28th International Conference on Human Factors in Computing Systems, pp. 163–172. ACM, Atlanta (2010)
3. Ducheneaut, N., Yee, N., Nickell, E., Moore, R.J.: The life and death of online gaming communities: a look at guilds in world of warcraft. In: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, pp. 839–848. ACM, San Jose (2007)
4. Constandache, I., Gaonkar, S., Sayler, M., Choudhury, R.R., Cox, L.: EnLoc: Energy-Efficient Localization for Mobile Phones. In: IEEE INFOCOM 2009, pp. 2716–2720 (2009)
5. Leontjev, A.N.: Activity. Consciousness. Personality. Prentice Hall, Englewood Cliffs (1978)

Educational Affordances of Ubiquitous Learning

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Abstract. This study aims to explore educational affordances on a natural science course with a ubiquitous learning environment. To address this research goal, this study employed a learning environment termed the Environment of Ubiquitous Learning with Educational Resources (EULER) and conducted a natural science course. The participants included elementary school teachers and elementary school students. Detailed studies of how the students use EULER and how this course affects their learning have enabled us to identify specific educational affordances. This study describes eleven educational affordances that have implications for current and future developments in pedagogy.

Keywords: educational affordance, natural science, ubiquitous learning.

1 Introduction

The term "affordance" was coined by the perceptual psychologist J. J. Gibson [3]. Gibson defined affordances as what the environment offers to humans and what it provides or furnishes, which may be for good or ill; it emphasizes possible actions that the observer perceives as feasible in the environment. Norman defined affordances as opportunities for action, that is, the perceived and actual fundamental properties of a thing that determine its possible uses [7]. Independent of perception, affordances exist whether or not the actor cares about them, perceives them, or has perceptual information about them [2]. Kirschner further defined educational affordances as those characteristics of an artifact that determine if and how a particular learning behavior can possibly be enacted within a given context [4].

Mobile learning that employs mobile devices (e.g., PDAs, smart phones, and iPODs) as learning tools has been thriving since recent years. Therefore, many studies are exploring the educational affordances that mobile devices can offer. For example, Klopfer, Squire, and Jenkins proposed five educational affordances of PDAs: portability, social interactivity, context sensitivity, connectivity, and individuality [5]. Patten, Sa´nches, and Tangney explored current mobile applications and used the functionality to describe what might be understood as the following seven educational affordances: administration, referential, interactive, micro world, data collection, location awareness, and collaboration [8]. Churchill and Churchill did an empirical

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study and found PDAs providing five educational affordances: a multimedia-access tool, connectivity tool, capture tool, representational tool, and analytical tool [1].

Although many studies had successfully explored numerous educational affordances of handheld devices, not many studies had induced the educational affordances of computer-assisted learning environments in a course. Our primary research question is as follows: What are the educational affordances of a learning package? Therefore, this study aims to employ a learning environment that includes diverse learning tools and rich learning resources as well as to conduct a natural science course that includes various theme-based learning activities in a real situation for exploring the educational affordances.

2 Methodology

A case study through a series of experiments was conducted using the EULER in a classroom and at Guandu Nature Park, a famous wetland in the Taipei area [9], for an eight-week natural science course [6]. Participants included four natural science teachers and 36 fifth-grade students. Qualitative analyses were used to explore the educational affordances.

2.1 Learning Environment

This study employed the ubiquitous learning environment—EULER—to help natural science learning. EULER consists of two subsystems, Mobile Interactive Learning Environment (MOBILE) server, which is built on a laptop computer for teachers, and mobile-tools (m-Tools), which are built on PDA platform for students. Teachers input material into the Mobile Content Database (MCDB) via Mobile Content Management (MCM) and establish assessments in the Mobile Assessment Database (MADB) via Mobile Assessment Management (MAM). The personal portfolio tool, m-Portfolio, saves each student's personal learning portfolio into the Mobile Learning Record Database (MLRDB) of the mobile server, making it available for teachers to review and assign grades. The MLRDB stores the student's records, including assignment grades, reading times, number of discussions, and instances of information sharing. Teachers preinstall the tests into the mobile server and conduct these tests using a MAM unit. Teachers use a Learning Activity Management (LAM) unit to construct a virtual classroom for each course, which supports many learning functions including bulletin boards, forums, voting, chatting, assignments, tests, and instruction. The m-Tools has fourteen functions, such as m-Messenger (receiving teacher guidance), m-RFID (processing RFID internal code), m-Loader (accessing course materials), m-Browser (browsing the contents), m-Player (playing multimedia files), m-AR (displaying virtual objects), m-Capture (recording videos and static photos), m-Notes (compiling information into articles), m-Sharer (sending data to peers), m-Test (taking tests), m-Calendar (organizing personal schedules), m-Voting (presenting personal idea), and m-Portfolio (recording personal learning records). The personal learning portfolio was saved in the m-DB.

2.2 Procedures

This study develops a natural science course based on the problem-based learning (PBL), collaborative learning (CL), and game-based learning (GBL) strategies that included several theme-based learning activities. The course was entitled "How can the gradually disappearing wetland ecosystems in Taiwan be protected and restored?" The course includes the following five activities.

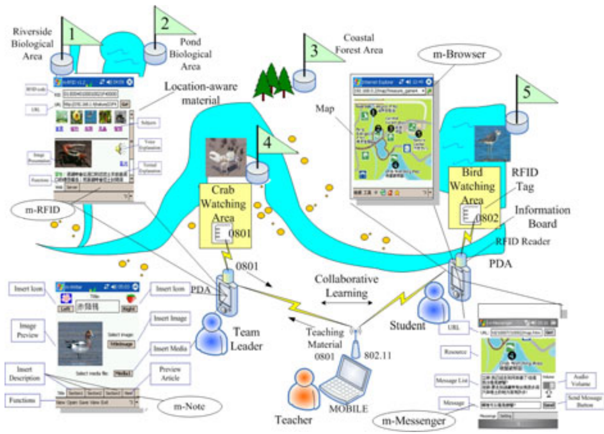

Fig. 1. The scenario of treasure hunt game

Teachers demonstrated how to use the EULER functions and introduced the course activities to the students before the activities began. Activity 1, the "Understanding the ecology of wetlands," was undertaken in the classroom. By using their PDAs, the students perused course materials and browsed media resources from EULER, collected information from the Internet, and shared knowledge with their classmates in order to understand the creatures and environment of the wetlands.

In activity 2, "Treasure hunt game" activity, each student carried a mobile device equipped with a video camera and an RFID reader when visiting scenic areas using the treasure map. Each student approaching a scenic area could use the learning device to identify the RFID tag. The detected identification code of the RFID tag was then transmitted via WLAN to the MOBILE server. The MOBILE server recognized the location of the student and then transmitted the context-aware content to the learning device. After completing a learning unit at one scenic area, he/she then continued to the next scenic area until all five areas had been visited. The student thus accessed context-aware content related to actual wildlife, which enabled game-based ubiquitous learning. Figure 1 illustrates the scenario of treasure hunt game.

In activity 3, "Wetland rescue" activity, the students selected a team project from among the themes. Each team member organized and collected evidential materials and retrieved relevant information from the MOBILE server and then compiled these materials into an article. The members engaged themselves in a group discussion on the basis of the articles and drew an inference for a selected problem. All articles were then sent to team leaders to edit a rich team report that was submitted to teachers by using sharing tool (m-Sharer).

In activity 4, "Unexpected encounter" activity, each student utilized the AR tool (m-AR) to watch virtual wildlife that would rarely appear in the wetland area. In activity 5, on completion of the course, teachers and researchers conducted an open-question survey, a yes/no- question survey, and in-depth interviews.

2.3 Data Sources and Analysis

After the learning activities, a survey was conducted to explore the educational affordances of EULER. In-depth interviews were conducted to explore the students' points of view, feelings, and perspectives after they completed all the learning activities. The data collected from on-line discussions were related to the students' reflections on their uses and exploration of m-Tools. The researchers observed the students' learning behavior and their use of m-Tools during the learning activities, and they documented the learning processes. The data was organized, and it classified the educational affordances relating to the proposed ubiquitous learning environment and course.

3 Results

We employed a representative student's response that was paraphrased to enhance readability as a sample for each affordance.

Actual educational affordances

1. Unconstrained Knowledge Accession—A student stated, "I wanted to know whether all crabs move sideways. I employed the browsing tool (m-Browser) to find the answer from MOBILE server, and I found that one of the species, the soldier crab (Mictyris brevidactylus), is an exception. Using these ubiquitous learning tools, I could easily acquire new knowledge."

2. Real-time Evaluation—A student noted, "Answering questions immediately on the PDA is a new experience. On an electronic test tool (m-Test), colorful graphics and sounds can be attached to each question. Compared with paper-and-pencil tests, electronic tests are more lively and interesting."

3. Individuality—A student noted, "During the learning activities, the portfolio tool (m-Portfolio) automatically recorded the materials I read, stored the graphics of crabs I captured, saved my homework, recorded the treasure hunt games I attended, and kept track of my test performance."

4. Diverse Interaction—A student stated, "Whenever we encountered problems during the "Wetland Rescue" activity, we used the communication tool (m-Messenger) to chat with our teacher and ask for assistance. The teacher also used it to guide us and give hints to the solution. All problems were finally solved after group discussion."

5. Data Collection—A student stated, “Whenever I observed anything interesting, I would easily use the video-capturing tool (m-Capture) to record the scenes in the PDA. For instance, I saw two crabs that seemed to be fighting, so I recorded them in a video file and uploaded the file to the MOBILE server.”

6. Gameplay —A student noted, “In the treasure hunt activity, when we arrived at the crab watching area, we used the m-RFID tool to get crab-related course materials. We would receive a virtual treasure after we completed the learning and passed a test in each zone. Finally, our team received an award after collecting the five treasures in the shortest time.” In the researcher observation, the students really enjoyed the treasure hunt game, so each team tried to do its best to win the award.

7. Authentic Context Awareness—A student stated, “In the activity, I saw fiddler crabs waving fiddle claws and waterfowls looking for food beside the pond. I could also reach out to touch Kandelia candel. This activity not only allowed me to read webpage-based materials any time but also to watch biological creatures closely.” In the interview, a student stated that the learning activity allowed him to watch wild creatures and deepen his understanding.

8. Immersion—A student stated, “During the “Unexpected Encounter” activity, when I walked into the crab area, I could not see any Uca lactea (a species of fiddler crab). Through the m-AR function of the PDA, I could see a virtual Uca lacteal waving its fiddle claws on the swamp that are not normally seen in the real world and even those that no longer inhabit the earth.”

Perceived educational affordances

9. Application—A student noted, “My classmate Eddy and I saw thousands of crabs marching on the sand. He asked me “Do you know approximately how many crabs are there?” I immediately counted the number of crabs within a square of 20 centimeters (twelve crabs) and estimated the area of this sand land (about 12 square meters). Later, I used the calculator on the PDA to determine that there were about 3600 crabs on this sand land.”

10. Ubiquitous revision—A student noted, ”I stored class handouts and teaching materials in the PDA and reviewed them while waiting for buses. These tools allowed me to review lessons at any time and any place, and they deepened my understanding and memory of the lessons.” In research observation, students usually reviewed learning materials stored in PDAs during leisure hours, thus increasing their familiarity with the lessons.

11. Seamless Collaboration—A student noted, “The title of our team report was “How to restore wetlands?” Melody captured the image of bank-protecting mud slopes and government beautification efforts. Carol found on the Internet that the government is currently dismantling unused fish ponds, filling them, and then removing waste on the land so that native plants can grow on the wetlands and provide a living environment for animals. Becky reported that the education center in the park was established to promote environmental awareness and is effective for teaching citizens to preserve the ecological system.”

4 Conclusions and Future Work

This study finds that the proposed EULER and natural science course provides thirteen educational affordances divided into two categories. The ubiquitous learning environment and course provided eight actual educational affordances, which included unconstrained knowledge accession, real-time evaluation, individuality, diverse interaction, data collection, gameplay, authentic context-awareness, and immersion. The students' responses identified three perceived educational affordances, which were application, ubiquitous revision, and seamless collaboration.

The educational affordances explicated in this study should be useful to teachers when they employ ubiquitous computing technology, rich educational resources, and diverse pedagogical tactics to improve the student learning effect and help students achieve their learning goals. Our future research will be dedicated to investigating the differences in educational affordances between different instructional environments and open courses using different learning tools, learning contexts, learning affections, theme-based activities, and instructional strategies.

References

1. Churchill, D., Churchill, N.: Educational affordances of PDAs: A study of a teacher's exploration of this technology. Computers & Education 50(4), 1439–1450 (2008)
2. Gaver, W.W.: Affordances for interaction: The social is material for design. Ecological Psychology 8(2), 111–129 (1996)
3. Gibson, J.J.: The theory of affordances. In: Shaw, R., Bransford, J. (eds.) Perceiving, Acting, and Knowing: Toward an Ecological Psychology. Lawrence Erlbaum Associates, Hillsdale (1977)
4. Kirschner, P.A.: Can we support CSCL? Educational, social and technological affordances for learning. In: Kirschner, P.A. (ed.) Three worlds of CSCL. Can we support CSCL, Heerlen, Open Universiteit Nederland, pp. 61–91 (2002)
5. Klopfer, E., Squire, K., Jenkins, H.: Environmental Detectives: PDAs as a window into a virtual simulated world. In: Proceedings of IEEE International Workshop on Wireless and Mobile Technologies in Education, pp. 95–98. IEEE Computer Society, Vaxjo (2002)
6. Liu, T.Y., Tan, T.H., Chu, Y.L.: Outdoor natural science learning with an RFID-supported immersive ubiquitous learning environment. Educational Technology & Society 12(4), 161–175 (2009)
7. Norman, D.A.: The psychology of everyday things. Basic Books, New York (1988)
8. Patten, B., Sánches, I.A., Tangney, B.: Designing collaborative, constructivist and contextual applications for handheld devices. Computers & Education 46, 294–308 (2006)
9. Wild Bird Society of Taipei, `http://www.gd-park.org.tw`

Development of a Mobile Rhythm Learning System Based on Digital Game-Based Learning Companion

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Abstract. Rhythm is an important aspect of music development of children. The drum is the instrument that is often played by children and helps them acquire rhythmic skills of music. There are, however, other sources and instruments that are used to create the effects of rhythm. Nevertheless, current education neglects the exploration activities of sound and its relationship with rhythm in elementary school. Based on the positive learning effects of digital game-based learning and learning companion, findings based on this research developed a mobile rhythm learning system that make the rhythm's learning anywhere and anytime possible. This digital learning companion leads the learner to explore a variety of sound material in the daily life. The learner can use the sound material as background music to the rhythm games, thereby enhancing rhythm learning by this system. In addition, the learner could collaboratively ensemble a rhythm game with their peers through Bluetooth connection.

Keywords: Mobile-learning, Game-based learning, Learning companion, Rhythm.

1 Introduction

Some music education research in Taiwan points out that child's learning motivation and effectiveness is enhanced by using the game-based learning (Chen, 2006; Yang, 2010). However, the current music learning activities are often limited in the classroom, and the students lack the opportunity to explore the environmental sound, as well as to create their own music works by themselves or collaboratively. The "Arts and Humanities" section of "Grade 1-9 Curriculum Guidelines" mentions that, the art education should provide students opportunities to explore their environment. The " Competence Indicators" section also calls attention to the fact that the schools have to offer fifth and sixth grade students with the experience of creating their works by using the appropriate notation or audio recording. The world famous rhythm band "STOMP" (2011) similarly adopts various common objects in daily life as the basic elements for creating rhythmic sound, such as buckets, brooms, newspapers. According to the suggestion of Chu's research (2007), applying STOMP's concept on the elementary music education can heighten a child's music interest and increase his/her

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appreciation of artistic ideas. And rhythmic learning is a very important and essential component in early childhood music education (Yao, 2000; Huang, 2006).

The main aim of this study is to develop a Mobile Rhythm Learning System (MRLS). MRLS allows the students to collect sounds anywhere as the source of musical materials by using the recording function of mobile devices. The learning companion in MRLS will encourage students to explore the sound of surrounding objects and aid in creating rhythm for the digital rhythm games. In addition, through the use of Bluetooth, they can ensemble some rhythmical pieces together. To develop MRLS, this study integrates digital game-based learning with a learning companion for the fifth and sixth grade children. MRLS can be used for enhancing, as well as developing, children's sense of rhythm, and to promote social skills through cooperative learning.

2 Background

2.1 Mobile-Learning

In a mobile-learning environment, learners can use mobile devices such as PDAs, smart phones, tablet PCs, without space and time constraints, through the assistance of communication technology, to carry out their learning activities. The traditional classroom is not the only place of learning. In a context awareness environment, students can be engaged in situation learning and augment the value of and the interaction between people and the surroundings. Many of the current research on applied mobile computing concentrate of its use in creating a museum guide (Huang, 2007), or expanding knowledge of plants (Chinnery, 2006), and English teaching (Chou, 2009), but little study pays attention to the application of mobile computing technology in music learning. Therefore, this study explores the characteristics and features of mobile devices and develops a MRLS system for music education in elementary school.

2.2 Digital Game-Based Learning

Digital game-based learning (DGBL) adopts digital games as a platform for learners to solve the various problems encountered in different learning domains. There are many different kinds of game such as gorgeous shot, and the exciting real-time environment, and they are easy for users to immerse in them.

According to Prensky (2001), currently more than half of the labor force belongs to the "Game Generation", who connect in early childhood with a variety of digital games, the Internet, MTV, and the electronic media. Their way of thinking, therefore, is fashioned differently from their elders. They are more skilled in parallel thinking, and can handle multitasks at the same time. They have the tendency to browse multimedia information than utilize the written text. Therefore, Game Generation may learn in a very different way than the generation of their parents, such as learning by mobile device or by game. Based on the previous literature, learning through digital games could enhance their motivation and learning effects, and to solve the problem of short attention span.

Digital game-based learning is applied in many learning fields, but again little research focuses on music teaching. Ke (2008) pointed out that the digital rhythm game used in the training, had positive learning effects. As a result, our research will design a series of digital rhythm games for elementary school's students to increase the scope of the learner's rhythmical skills.

2.3 Learning Companion

The learning companion, in the learning process, may play a role of learning guidance or as a learner's peer. And the close interaction between students and learning companion can help them successfully learn and increase their learning motivation (Chan, 1988).

Hsiao et al. (2010) posits that game-based learning can pose a dilemma whereby the learner's attention is on the game only for its entertainment rather than its learning value. So the game must provide a guiding role with the learners enabling them to focus on learning activities. In addition, Oh and Woo (2008) show that if the role of learning companion offers strong mentoring, learners will regard the learning companion as teachers, thereby ironically the learning companion will lose it function and value as a learning tool. Therefore, the role of learning companion walks a find line between a guide and a companion, in order to maintain and increase the learner's trust and to not lose its ability learning.

In this study, the learning companion is designed to be a virtual pet raised and nurtured by the learner. The player (the learner) needs to play rhythm games to accompany and train his/her pet, and use mobile devices to collect audio materials to help it to successfully return to its' home. When the player encounters difficulties during the game, the pet can also give a timely prompt and assist in reaching his/her the goal of the learning process without much delay. For example, in the rhythm game, when a player's score is not excellent, the pet can present as equally worthy of playing more basic level games, and thus provide the means and the challenge for the player to advance to higher levels of competency. In addition, the player can transform his/her pet into some different form or endow him with a nature, in order to favor the learner's ability to learn.

2.4 Rhythm Learning

Orff method and Dalcroze method are two of four prevalent techniques used in music teaching in Taiwan (Cheng, 2002). Yao (2000) pointed out that the Orff teaching method emphasizes the rhythm and improvisation-based teaching ideas; Dalcroze method also emphasizes the importance of teaching rhythm in early childhood. Huang's (2006) study also found that children learning percussion instruments outperform in creative thinking, precision and personality characteristics, than normal children. Therefore, strengthening the sense of rhythm for the elementary school's students can indeed have positive learning effects.

There are many groups for creating non-traditional music overseas. STOMP (2011) is one of them. A notable feature of this musical group's appeal is creating rhythm without recourse to traditional musical instruments such as drums or timpani. Its instruments are entirely from daily life: trash can lids, brooms, pots and pans and the actors own body parts. And that is STOMP makes music creatively through such those common but special "instrument" rhythmical tools. According to Chu (2007), applying this concept in elementary music education can increase the learning interest of children, therefore reducing the range of difficulties for learning music. Chu (2007) summarized the following features:

- Percussion instruments have no pitch problems and possess a variety of features. It can be used as introductory musical instruments.
- The "STOMP" method can improve student observation, appreciation, creativity and teamwork abilities.

Therefore, this study will encourage students to use the recording function of cell phone for collecting the surrounding sounds and use those sounds in the digital rhythm games.

3 System Development

This research develops a MRLS system using mobile and web technology. In MRLS, Children can adopt the Android smart phone as device of mobile learning, and raise their virtual pets which are their learning companions. Their pets will prompt learners to do some tasks which children carry out playing a variety of rhythm games such as being engaged in sound collection activities. In the system development of this study, we adopted MVC (Model, View, and Control) software model to develop MRLS system. Client-side modules used in Android smart phone are designed in Java language, while the server-side modules are devised in PHP. The children's music and learning profiles can be uploaded automatically into MRLS server, and children can update newer version of digital rhythm games and other client-side functions. In addition, the teachers can employ system module to analyze their students' profile and to assess their music works. The framework of MRLS system is shown as Fig. 1. Its functions are depicted as follows:

3.1 The Rhythm Game for Single Player

Each rhythm game lasts for about 3 to 5 minutes under the background music. The virtual pet will sing songs with the melody, and ask the player to help to beat the rhythm part, shown as Fig. 2 (a). When starting to play, some bubbles will appear at the top and fall down to instrument buttons. The player need to hit the button for creating rhythm sound when a bubble touching the button. The virtual pet will give feedback to the player according to his/her beating accuracy, such as "Awesome! ", "Yes! ","Oops!" and so forth. Under such learning environment, the player can grasp the beating skills of rhythm and immediately correct their rhythm.

3.2 The Rhythm Game for Double Players

Through Bluetooth connection, the player can ensemble a rhythm game with his/her peer. While the Bluetooth connecting, the pets of the two players will appear in the same screen , shown as Fig. 2(b). At this moment, they can play with the same game

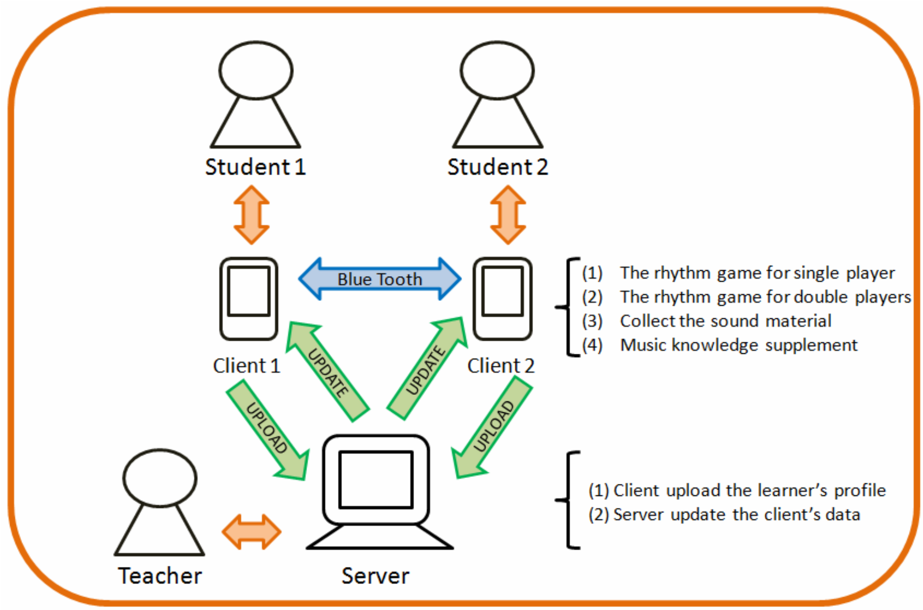

Fig. 1. The framework of MRLS

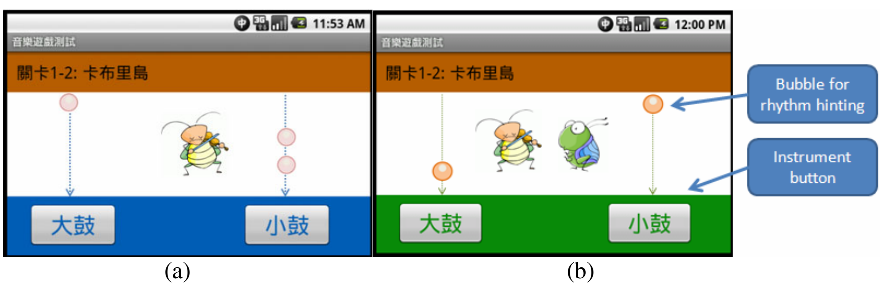

Fig. 2. An example of rhythm game for (a) single player and (b) double players

simultaneously, that is, they are in charge of beating individual rhythm, and finally the composite sound will be heard in both cell phones. The two-player version of rhythm game can be adopted to foster the learner to play collaboratively. In such environment, they can enhance their social skills through music communication.

3.3 Collecting the Sound Materials

Pets will request learners to attain the sound material available in daily life by giving the prompts of characteristics of sound. For instance, the sound features may be "clear, crisp sound like glass-beating". In addition to prompts, the pets will have to offer learners guidance or scaffold by giving a sound sample or learning material. To stimulate the learner out of the classroom, in ordinary life can also pay attention to various substances, materials, sound effects that occur. Learners can be by phone recording, to take the sound sample. Due to system limitation, the pets cannot judge the quality of sound materials collected by children. After learners gather good material, they can put them into a rhythm game and play with it. Learners could understand the role of the sound, and to stimulate their motivation for re-looking.

3.4 Music Learning Content: Knowledge Supplement

During idle time, the pet will actively show a prompt and ask the learner to survey the music knowledge with it, shown as Fig. 3. Through the message dialogue, learners can attain some of the basic concepts of music. The music knowledge offered by MRLS is comprised of basic music theory, introduction of musical instruments, some famous composers and so on. To measure the learning effect, the pet will ask the learner to answer the music questions after providing music learning content, and offer feedback according to their replies.

3.5 Server-Side Functions

After the learners playing the game by mobile phones, their learning profiles will be automatically uploaded into the server through Internet. The teachers can adopt server-side module to analyze and understand student's learning states, depicted as Fig. 4. The learning profile consists of the correct rate of beating the rhythm game, the sound the learner collected, and the state of pet the learner raised. The teacher can offer learning opportunities to remedy or enhance the learner's music skills or knowledge. In addition, the teacher can provide different songs, music learning content by uploading into server. The students can share their works with their peers and update new version of client-side functions as well.

Fig. 3. Snapshot of asking questions by pet

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觀看細節	項目名稱	數值
	手機型號	IDEOS
	遊戲開始時間	2011/03/05
More Detail	遊玩總時數	3 hrs 34 mins
More Detail	完整遊玩關卡數	21
	總計敲打狀況	135 perfect, 535 good, 277 bad
More Detail	平均每場敲打正確率	14% perfect, 56% good, 29% bad
More Detail	聲音素材蒐集完成度	13%
More Detail	禮物蒐集完成度	8%
	遊戲關卡開放程度	3-1
	寵物名稱	小白
More Detail	寵物心情	Good
More Detail	藍芽連線總場數	6

Fig. 4. An example of student's profile in MRLS

4 Initial System Evaluation

In order to examine the suitability and stability of MRLS, this study employed 22 undergraduate students to evaluate the system. Each participant was allotted a cell phone for testing client-side functions of the system in one week. After experiment, they are asked to complete a system evaluation questionnaire of 4-point Likert scale. The questionnaire is used for survey the perception and learning experience of digital learning companion. Only six Android cell phones are used in this study, this experiment lasts for 4 weeks. The statistical results of the survey are shown in Table 1.

The results indicates that the participants are interesting in using smart phone to operate MRLS including playing the rhythm game and collecting sound materials. Learning companion is useful of guiding the students to learn rhythm skills in a digital game. However, the difficulty degree of the game is too easy for undergraduate students, probably because the initial design is based on cognitive state of the elementary school's learners. In addition, the phone's screen size is too small to read the text document.

Table 1. The statistical results of system evaluation

Items	Strongly Agree	Agree	Disagree	Strongly Disagree	Mean	Standard Deviation
1. The rhythm game is fun and interesting.	18%	68%	14%	0%	3.05	0.58
2. The difficulty degree of rhythm game is moderate.	9%	50%	36%	5%	2.64	0.73
3. The virtual pet can increase your motivation in playing the rhythm game.	27%	68%	5%	0%	3.18	0.66
4. The pet can guide you to complete its requests (duties).	0%	73%	27%	0%	2.73	0.46
5. Recording function of cell phone is convenient and easy to use.	9%	59%	23%	9%	2.68	0.78
6. Grasping sound material by cell phone is interesting.	9%	82%	9%	0%	3.00	0.44
7. Putting your own recorded sound clips into the rhythm game is more interesting than the default sound.	18%	73%	9%	0%	3.09	0.53
8. After playing the rhythm game, your sense of rhythm is enhanced.	9%	64%	23%	5%	2.79	0.69
9. Double player games are more attractive than the single one.	23%	73%	5%	0%	3.18	0.50
10. The screen size of the smart phone is suitable for children to view text document.	0%	50%	41%	9%	2.41	0.67

5 Conclusion

This study utilizes the characteristics of mobile devices and adopts the theory of learning companion to develop the MRLS system. Under MRLS, students can collect the surrounding sound anywhere in daily life. Through guidance of the learning companion, the students can drill and practice rhythm in a digital game. The MRLS can be used for improving the student's basic sense of rhythm and to explore a variety of source of rhythm. After system evaluation, the participants give high appraisal towards system function and usefulness. In the future, this study will enhance the readability of user interface under the limitation of the screen size of cell phone, and improve the art design of graphics. This study will employ teachers and pupils of elementary school to assess MRLS. In addition, the research will conduct a experimental learning by quasi-experiment design in elementary school to investigate the learning effects of MRLS system.

References

1. Chan, T.W., Baskin, A.B.: Studying with the Prince: the Computer as a Learning Companion. In: Proceedings of International Conference of Intelligent Tutoring Systems, Montreal, Canada (1988)
2. Chen, M.I.: A Study on Metacognition and Learning Attitude of 6th Graders through Play-Based Music Appreciation Instruction. Unpublished Master's Thesis. National University of Tainan, Taiwan (2006)
3. Cheng, F.C.: Comparison and Application of Four Contemporary Music Teaching Methods. Fuwen, Taiwan (2002) (in Chinese)
4. Chinnery, G.M.: Emerging Technologies Going to the Mall: Mobile Assisted Language Learning. Language Learning & Technology 10(1), 9–16 (2006)
5. Chou, K.C.: The Development and Experiment of Outdoor Inquiry-Based Mobile Learning Management System with RFID and Hand-Held Device. Unpublished Master's Thesis. Taipei Municipal University of Education, Taiwan (2009)
6. Chu, C.Y.: Action Research of Utilizing the Percussion Instruments as Teaching Vehicle - as STOMP for example. Unpublished Master's Thesis. Taipei National University of the Arts (2007)
7. Hsiao, H.S., Huang, Y.H., Hong, W.T., Lin, C.Y., Tsai, F.H.: The Study of Online Game-Based Learning System with Learning Companion. International Journal on Digital Learning Technology 2(2), 1–21 (2010)
8. Huang, C.Y.: The Research of the Effect on Creativity and Its Relative Factors by the Students Learning Percussion through Elementary and Junior High School Concert Band. Unpublished Master's Thesis. Taipei National University of the Arts, Taiwan (2006)
9. Huang, S.W.: The Study of Game-Based Inquiry Guided Learning System in Museum Learning - Using Shihsanhang Museum as an Example. Unpublished Master's Thesis. National Taiwan Normal University, Taiwan (2007)
10. Ministry of Education.: Grade 1-9 Curriculum Guidelines (2008), `http://www.teach.eje.edu.tw/9CC2/`
11. Prensky, M.: Digital Game-Based Learning. Paragon House, Saint Paul (2001)
12. Ke, C.H.: A Study of Rhythm Training in Online Rhythm Game. Unpublished Master's Thesis. Southern Taiwan University, Taiwan (2008)

13. Oh, S., Woo, W.: ARGarden: Augmented Edutainment System with a Learning Companion. In: Pan, Z., Cheok, D.A.D., Müller, W., El Rhalibi, A. (eds.) Transactions on Edutainment I. LNCS, vol. 5080, pp. 40–50. Springer, Heidelberg (2008)
14. STOMP's Official Website (2011), `http://www.stomponline.com/`
15. Yang, J.H.: A Study of Applying Play Teaching to Music Curriculum for Learning Motivation and Achievement in Elementary Third Grade. Unpublished Master's Thesis. Taipei Municipal University of Education, Taiwan (2010)
16. Yao, S.T.: Music Education and Music Acts – Theory and Methodology. National Taiwan Normal University Publisher, Taipei (2000)

Motivations for Game-Playing on Mobile Devices – Using Smartphone as an Example

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Abstract. Motivations for game playing have always been an important topic for research. Through understanding these motivations, game manufacturers develop games based on specific demand. The smartphone combines different technology and sensors which causes the motivation for game playing to become more complicated. The goal of this study is to discover the reason for game playing on smartphones through understanding both the intrinsic and extrinsic motivations of the motivation theories. Furthermore, it hopes to determine which motivation has a deeper impact on players in general.

Keywords: motivation theory, technology acceptance model, mobile game, social influence.

1 Introduction

Powerful smartphones use various techniques such as the touch screen which users can play by intuition, or with a variety of sensors to create different ways to play. With the prevalence of wireless network services, it has become more convenient for people to download applications. The smartphone game has increased its popularity in recently years, as one observes the existence of thousands of games designed for this device. And the primary focus of this research is how people decide which game to choose. This study aims to explain the motivation as to why people play smartphone games, providing suggestions for the smartphone game manufacturer.

2 Conceptual Model and Hypotheses of Mobile Games

The model for this research is based on TAM [1], with the context referring to the user behavior in mobile games. The conceptual model refers to Motivation theory to subdivide factors into intrinsic motivation and extrinsic motivation [2], [3]. In this model, it defines perceived ease of use (PEU) from TAM and perceived playfulness (PP) as intrinsic motivations. In the hedonic information systems, perceived ease of use and perceived playfulness are stronger than perceived usefulness [4]. Perceived playfulness defines users enjoyment in the regard of the game content (e.g.,

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gameplay, user interface...). In regard of extrinsic motivations, subjective norm (SN) [5] and social interaction (SI) are external effects that people concern not with the game content but the result. Subjective Norm is defined as user's perception concerning other people's is also influenced opinion for, by against mobile games. The social interaction refers to people's interaction with others people through playing social games. The social game is defined as the interaction between various people through network, "or in the case of multiplayer play on one phone".

Attitude toward playing mobile games may be affected by both intrinsic motivations and extrinsic motivations; and further, attitude is directly related to intention of playing mobile games. Amabile[1] suggested that extrinsic motivation and intrinsic motivation can't distinguish clearly [2]. The feature of smartphone such as mobility and wireless network, external factors may influence user thought.

3 Experiment

This research attempts to collect information from selected participants to observe user behavior while playing games. The goal of this research is to observe the human interaction, communication and influence of mobile entertainment on smartphone. For this purpose, 29 students who participated in the project "X-mind" were selected for a one-year experiment. Their smartphones all use android system and each one has at least 3 to 6 months of experience using smartphone. All the phones had a special application installed for the purpose of capturing information on each user's behavior on smartphones. First this study collects the data in order to calculate the number and the time/date for games played on smartphone. Then one person was chosen for the purpose of personal interview. Through playing three of the most played games and interview to understand the motives for playing games. Finally, the collected data and the interview content will be combined and analyzed to gain a better understanding for factors that might influence users to play games on smartphone.

4 Discuss and Analysis

4.1 Members Data

To protect participants' privacy, each one is represented by a number. The final result is based on information collected from 25 participants, since four of them did not return any data. Among them three users did not install any game. Among all the applications installed on smartphones, nearly one-fifth of them are game-related applications, and among these games, 53 of them are paid ones and 40 of them are not offered by the android market but installed by users through game websites or game forum. This research measures the time and energy spent on game playing through the frequency of game playing, the number of installation of game application and types of game installed. User 27(owns 67 games, frequency for playing games is 513) and User 30(owns 58 games, frequency for playing games is 394) have the highest amount of installed games and highest frequency in game playing. User 27 only plays single-user games while User 30 prefers social games. This research also attempts to understand the sustainability of attractiveness for each game by its frequency of being played.

4.2 Interview

The participants were chosen based on the fact that each owns more than 50 games, plays game almost daily, and has played social games for a long time. Based on the data collected, User 30 was chosen for personal interview. Table 1 below shows the games played most often by User 30:

Table 1. The games played most often by user 30

Game name	Frequency to play	Game type	content
Foursquare	117	Social game	Through logging in, user can mark the location; user can collect different badges through log-in, and can become landowner with the highest number of log-in.
Spiderman (not offered by android market)	26	Action game	Through touch screen, the character in the game can jump to the next platform; the challenge of the game depends on the platform, wind speed and wind direction.
Game Dev Story	22	Simulation game	User pretending to be the owner of game company, simulating running a game business, including development of games and their platforms, firing employees and training staff…etc

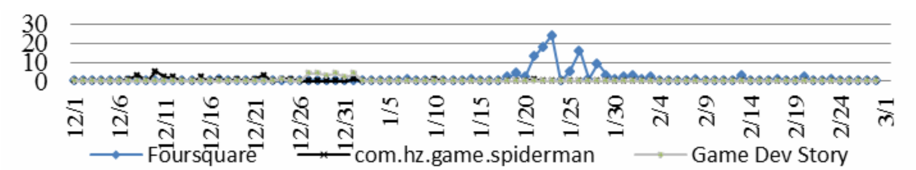

Fig. 1. The frequency of User 30 to play games

Figure 1 shows the detail on User 30 plays. User 30 has played Game Dev Story merely for 7 days during 4 months. There are two days of rest after participant's first application. Even though the intervals between playing time was getting bigger, Spiderman was still being played. And User 30 before playing Foursquare and after playing that uses application likes Figure 2 on the other hand, shows the activities User 30 performed before and after playing Foursquare, and it is apparent that the applications User 30 preferred the most was for the function for browsing and taking pictures.

After playing this game for a while, I started the habit of taking pictures at the landmark and sharing them.(MOV00:0827-0833)

This study categorizes the content of interview as Table 2. From the interview, user 30 seems to be under the influences of factors proposed in this study. Also, maybe because of the game features and design, user 30 seemed to develop addiction due to the combination of various technology.

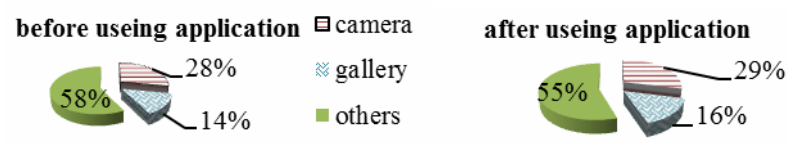

Fig. 2. Activities performed before and after playing Foursquare by User 30

Table 2. The factors of our model and interview content

Perceived playfulness	
Foursquare for participant, is interesting because user can log in the same place frequently be the mayorships, and makes to the user want to play games, as well as the badges collecting.	*It would give me badges after I log in ten times, twenty-five times, and fifty times. ...For a while I wanted to have a badge for being a super user. I also got a badge as a "book worm" when I log in to library several times pretending to be a hard-working student .... (MOV00:0743-0759)*
Perceived ease of use	
User 30 thought the game operation is simple and it is easy to play. Characteristic of this game is that one does not have to think too much while playing and it can be closed at any time.	*At first what I downloaded is not the same as what I imagined... In fact the interface is simple. But I don't know why, I just started to push the buttons and starting playing. (MOV00:1630-1650)*
Subject norm	
SN has influenced users' behavior for their intention to play game, increases their curiosity and makes them indulge in the games.	*I play because I want to keep on competing against my friend and to improve my skills(character). (MOV01:0108-0109)*
Social interaction	
The interactive mechanism provided by the game allows the user to either compete or collaborate with others to achieve his/her goal, and this may influence to user's mood.	*Now the mayorships is not me because it is taken away by another person, a little unhappy.(MOV00:0233-0238)*
Extrinsic motivation effect on intrinsic motivation	
User 30 had given up playing this game because of its difficulties to play, but through the extrinsic motivations such as the encouragement and explanation from friends, user 30 changed his/her mind and started playing again.	*At first I am not enthusiastic to play the game because it is too complicated... But my friend plays, and he seems to enjoy the game. I asked him how to play and teach me. I start to play again, and enjoy it. Because someone teaches me, it becomes easy... (MOV00:1939-2010)*

This research learned that perceived of use, perceived playfulness, and subject norm can influence user's willingness to play games. At the same time, the extrinsic motivations can influence the intrinsic ones. From the interview, the user can develop an interest to a game through the explanation and encouragement from friends, even if the game is difficult to operate (Fig 3).

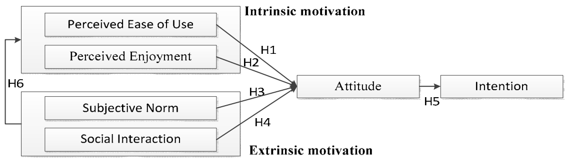

Fig. 3. The research model

5 Results and Limitations

This research has shown that every factors can influence the willingness to play games; if the operation is simple, the user would still play even if the picture quality is poor. On the other hand, game features and rich content can also inspire frequent game playing. The limitations of our experiment can be divided into two parts: program and user. Because the program can only collect and record the specific amount of time when users use certain applications, when users open another application or put the phone on stand-by mode, the recorded time could not reflect the actual playing time correctly. Sometimes the phones would lose power or break down, or when the SIM cards were changed, they would all affect the data recording process. One hopes by explaining the motivations of user playing game on smartphone: game designer may be inspired and develop new games. The exploration of how intrinsic and extrinsic motivations influence player behavior is especially for game marketing and the development smartphone games. Also, the research model "extends" from TAM for smartphone games.

Acknowledgments. This research is partially supported by National Chengchi University's Top University Project (http://excellence.comm.nccu.edu.tw/index_en.html). We owe our thanks to four professors, Dr. Yi-Shin Deng, Tsai-Yen Li, Wen-Hung Liao and Chiung-wen Hsu and two TAs, Cheng-ho Chen and Po-ming Chen. Thanks also go to all the participants in the experiments.

References

1. Davis, F., Bagozzi, R., Warshaw, P.: User Acceptance of Computer Technology: A Comparison of Two Theoretical Models. Management Science 35, 982 (1989)
2. Amabile, T.M.: The social psychology of creativity: A componential conceptualization. Journal of Personality and Social Psychology 45, 357–376 (1983)
3. Davis, F.D., Bagozzi, R.P., Warshaw, P.R.: Extrinsic and Intrinsic Motivation to Use Computers in the Workplace1. Journal of Applied Social Psychology 22, 1111–1132 (1992)
4. Heijden, H.V.d.: User Acceptance of Hedonic Information Systems. MIS Quarterly 28, 695–704 (2004)
5. Ajzen, I., Fishbein, M.: Understanding Attitudes and Predicting Social Behavior. Prentice-Hall, Englewood Cliffs (1980)

A Method for Determining Classroom Seating Arrangements by Using Bioinformatics

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Students in a classroom often feel an uncomfortable situation in classroom seating arrangements. This study focuses on the effects of classroom seating arrangements changes on motivation of learning and on interaction between students. In this study we inspect the classroom seating arrangements and the tendency of behavior of students by the difference of their seats. We also propose a method for determining the classroom seating arrangements by using a genetic algorithm to improve the learning environment. We carry out a questionnaire about classroom seating arrangements. We also inspect the effects of human relationship between students, flexibility of each student for classroom seating arrangements and behaviors of students of choosing the seats. A model of the classroom seating arrangements is constructed by using the results of the questionnaire and an analysis of an observation of behaviors between students.

In order to determine the optimal classroom seating arrangements, a genetic algorithm is applied on the basis of the questionnaire results and the analysis of the observation of behaviors between students. Our optimization problem is to determine the combination of classroom seating arrangements in such a way that the minimum of fitness rates of all students is as large as possible.

Two kinds of calculation results are obtained in the case where final generations are ten thousand and hundred thousand. Experiments in the classroom are carried out by using two kinds of classroom seating arrangements. We compare our proposed classroom seating arrangements with traditional one that is determined by using students ID numbers or intentions of the students and the homeroom teacher.

From the questionnaire of the classroom seating arrangements, it is found that satisfaction of each student for our proposed method is higher than the traditional classroom seating arrangements. It is also found from another questionnaire that each student is actually comfortable in the classroom because of the relations between other students. It is confirmed from the experimental results that the proposed method was effective. This proposed method can determine the classroom seating arrangements by a simple process in a short time. When teachers make classroom seating arrangements to improve the effect of learning, this research can be used effectively for an evaluation and an improvement of teaching.

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Explore the Next Generation of Cloud-Based E-Learning Environment

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Abstract. Advances in learning technologies offer new opportunities in enhancing learning that are taking place throughout the world. And cloud computing technologies have changed the way applications are developed and accessed. The new technologies enable the personal learning environment, utilising a range of tools to meet their interests and needs. Cloud-based applications are accessed from a web browser available anywhere and anytime. The following article we presents a mashup personal learning environment (MUPPLEs) that learning resources from emerging information of social networks. Learners can specify certain Web2.0 services and combine them in a MUPPLEs. This paper presents a cloud computing based solution for building a mashup personal learning environment which combines a wide range of technology, and tools to create an interactive tool. The platform offers reliable and scalable cloud-base services for E-learning platform and utilizes constructivist pedagogical approaches to learning and teaching under the personal learning environment.

Keywords: Cloud computing, Mashup Personal learning Enviroment, Social networking.

1 Introduction

In recent years, E-Learning has grown into a widely accepted way of learning. Recent advances in multimedia and communication technology provide an opportunity to build a self growing, unit sharing personal environment for teaching and learning. It is an innovative approach for delivering well-designed, learner-centered, interactive and facilitated learning environments to anyone, anyplace and anytime [5].

As a typical internet application, an E-learning system is facing challenges of optimizing resource management and provisioning. With the huge growth of users, services, education contents and resources, E-learning systems become more and more large-scale. Due to the large amount of learning resources and learners the learning network can show emerging patterns.

The main contribution of this paper is to building a MashUP Personal Learning Environments (MUPPLEs), which are used for combining different information from various sources of Web2.0. The MUPPLEs can support individual learner with personal competence development. Most of the sources are free to use and selected by

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the learner. The MUPPLEs offer a better learning goal attainment and to spend less time to search for suitable learning resources [2].

Many applications such as word processing, spreadsheets, presentations, databases and more can all be done inside a web browser, while the software and files are housed in the cloud. Browser-based applications are accessible with a variety of computer and even mobile platforms, making these tools available anywhere the Internet can be accessed. In addition to productivity applications, services like YouTube, Google Docs and Facebook, as well as a host of other browser-based applications, comprise a set of increasingly powerful cloud-based tools for almost any task a user might need to do especially in E-learning applications. Furthermore, it is very easy to share content created with these tools, both in terms of collaborating on its creation and distributing the completed work.

Cloud computing application technologies can provide on-demand access to applications served over the Internet in a dynamic and scalable manner. Moreover social networking technologies provide a means for easily sharing applications and data. Our service is built on a cloud computing infrastructure that dynamically provisions virtualized application servers based on user demand.

The purpose of this paper is to present a cloud computing based solution for building a personal learning environment which combines a wide range of technology, tools for education, and mashup of various learning services and applications. This paper is organized as follows. Section 2 describes the challenges of current E-Learning systems; Section 3 describes Personal Learning Environments and pedagogical approach; Section 4 briefly introduce what is cloud computing; Section 5 is demonstrates the practical application of Cloud-Based Personalized e-Learning platform; and Section 6 is the summary.

2 Challenges of Current E-Learning

The rapid advances in technology in the last few decades have had a significant impact on work, life, culture and social interaction. What kind of skills students need to develop to be prepared for the jobs of the 21st century is different from what they needed 10 years ago. So it is becoming clear to students, that traditional methods are unable to address the needs of education where the emphasis is on higher order learning experiences and outcomes demanded of a changing knowledge and communication-based society. It is increasingly recognized that using technology effectively is essential to providing high quality education and preparing students for the challenges of the 21st century.

Therefore, through this initiative, the latest generation of students can explore the multimedia world of E-education with the help of an innovative interface and discover that life-long learning is fun. But how are the teaching methods of the future being applied? Although the new technologies play an important role in the development and emergence of new pedagogies, where control can shift from the teacher to autonomous learner, but the change is very slow.

Despite the critical need for a paradigm shift from the teacher-centered approach to student-centered constructivists approaches whereby students construct knowledge through interaction and collaboration. But the bulk of today's E-learning systems still consist of simple conversion of classroom-based content to an electronic format while still retaining its traditional distinctive knowledge-centric nature [8]. So we think it is necessary to adopting constructivist approaches that can better equip our student for the needs of the 21st century.

One major drawback of existing E-learning system is that it is content-centric. Many instructors simply move all their teaching materials to the system. The materials are presented uniformly to all learners regardless of their background, learning styles and preferences [4]. But nowadays, we are seeing the trend in education that emphasis on learner-centric learning.

In the other hand, currently, more and more learners can be technically responsible for looking after their own learning materials. But many of them will in fact fail to back up this content on their devices, and a large ratio of it will be lost, particularly in the lifelong learning context, where there are multiple opportunities throughout life to lose or damage hardware and data.

3 Personal Learning Environments and Pedagogical Approach

Currently, the most common Course Management Systems (CMS) or Learning Management Systems (LMS) is Moodle, that also known as Virtual Learning Environments (VLEs). VLEs are electronic platforms that can be used to provide an easy to use system for flexible delivering learning materials and activities, and provide a single point of integration with student record systems.

In the last few years a new wave of web services such as Facebook, Twitter, Flickr, and social networking, knows as Web2.0, become a major service that support content publishing over the Internet. Applying Web 2.0 services to E-learning can enhance interactive communication and collaboration among participants and learners who either possess related learning resources, or can help to discover and obtain the resources, or are willing to exchange and share the resources with others in the Web-based learning [6].

Thus, Web 2.0 provides a learning environment have the use of social networks that can cross institutional boundaries, and the use of networking protocols (Peer-to-Peer, web services) to connect a range of resources and systems within a personally-managed space. This kind of environment is named Personal Learning Environment (PLE) [19].

Adoption of PLEs as the platform for e-learning is motivated by three reasons. The most important is that PLEs help learners manage their learning content and process. Second, PLEs providing support for learners to set their own learning goals. Third, in the PLEs learners can communicate with others in the process of learning, also can join into groups and have a suitable environment to practice social skills.

The web-based PLEs like Moodle, which have an architecture that supports a rich installation for extension points for PLEs' components. Social networking service like Facebook includes a number of APIs that enable developer to produce a learning context as simple as building a Facebook entry for a class and then associating a number of Facebook applications with the context [6].

In the following, we will present pedagogical approaches of PLEs and Mashup Personal Learning Environments (MUPPLEs).

3.1 Constructivist Pedagogical Approach

Social constructivism views each learner as a unique individual with unique needs and backgrounds, so that leaeners can build a PLE meet own needs by self. For example, learner can use iGoogle to controlled components as Google Docs, Google Calendar, Gmail, YouTube and some social network gadgets in the canvas view. In fact, Google Apps for education resemble this kind of PLEs. On the other hand social constructionist pedagogy based PLEs, such as Moodle which is web service especially built for E-learning, provide self directed pedagogy where user can be a member of a social network of common learning goals by reciprocal learning.

A learner-centric learning will give learners a deeper and richer learning experience, as there is greater participation and involvement in the learning [1]. This pedagogical approach supports lifelong learning and endeavors to promote empowerment of learners, while producing personalized learning experiences. In the PLEs learners are expected to actively engage in the learning process to construct their own learning. It is important to achieve the right balance between the degree of structure and flexibility that is built into the learning process. Thus they have more responsibility motivation for their learning.

3.2 Mashup Personal Learning Environment

Learners can choose the applications and services that constitute his/her PLE, be able to add new applications, whether from the set of pre defined tools or own ones, and be able to integrate data from different resources to produce a new service. Such a solution is called mashup PLE [11].

Currently, many learning management systems such as Moodle provide their own mechanisms to enable third party widgets to be included by users. The users can make advantage of public APIs of Web2.0 services and standardized XML formats be developed for each one using the native programming platform of the system.

PLEs provide personalized pedagogical assistant to the learner such as recommendation of common interest material. Single systems like Delicious or Flickr offer recommendations to their users based on their data and also researchers take advantage of single Web2.0 services to create recommender systems [3]. However, the combination of different Web2.0 services to recommend information based on mashed tag and rating data has not been attempted so far and especially not for learners in mashupPLEs. Thus, mashed up offers a new approach by mashing data of learners from various Web2.0 services to provide pedagogical recommendations.

Personal Learning Network (PLN) is a collection of resources that can help learning. Nowadays, “mashing” information becomes a widely used activity on the internet. This includes family and friends, teachers, and people in the local community. It can also include non-human resources, such as books, journals and other forms of media.

4 Cloud Computing

The concept of “cloud computing” is about the delivery of services that run in a web browser; the type of services range from adaptations of familiar tools such as e-mail to new offerings such as virtual worlds and social networks. And storage of data is an important service that can access the service anytime, anywhere, share data and collaborate more easily, and keep their data stored safely in the infrastructure.

Technically, it is a computing paradigm in which tasks are assigned to a combination of connections, software and services accessed over a network. This network of servers and connections is collectively known as the cloud. Users can reach into the cloud for resources as they need from anywhere at anytime. For this reason, cloud computing has also been described as "on demand computing."

In addition to productivity applications, services like Google, took cloud computing a step further by offering a suite of free word-processing and spreadsheet software over a browser. Google Apps, Maps and Gmail are all based in the cloud, as well as a host of other web-based applications, comprise a set of increasingly powerful cloud-based tools for almost any task a user might need to do especially in E-learning applications.

The typical uses of cloud computing to academics are [7]:

- A convenient tool to engage in the scholarship of teaching and learning;
- Personal Learning Environments (PLEs) used by many people as an alternative to institutionally controlled;
- Virtual Learning Environments (VLEs)/LMS with different personalised tools to meet their own personal needs and preferences;
- Provides opportunity for ubiquitous computing;
- No need for backing up everything to a thumb drive and transferring it from one device to another;
- No need to copy all stuff from one PC to another when buying a new one. It also means you can create a repository of information that stays with you and keeps growing as long as you want them;

Educational institutions are beginning to take advantage of existing applications hosted on a cloud that enable end users to perform tasks that have usually required site licensing, installation, and maintenance of individual software packages [9, 10]. Most of all, cloud applications to provide students and teachers with free or low-cost alternatives to expensive, proprietary productivity tools.

5 Practical Application of Cloud-Based Personalized E-Learning

This section presents a web-based E-learning system that utilizes various social networking services of Web 2.0 and available in cloud. This platform is an Open Source project by Moodle source code based on PHP5, MySQL database, Apache Server and run at Linux Operating Systems.

The platform allows the learners to personalise emerging information of a community to their preferences. They can choose information of the Web2.0 sources which they like.The components of the platform are shown in Fig. 1.

This PLE where various web-based service is designed by Moodle as a portal to these applications to support lifelong learning. This Web Server is responsible for user interaction, authentication of users, registration of new users and stores log messages and monitors user actions in the system. That also establishes the connection between the Web2.0 services and gathers new data into the repository.

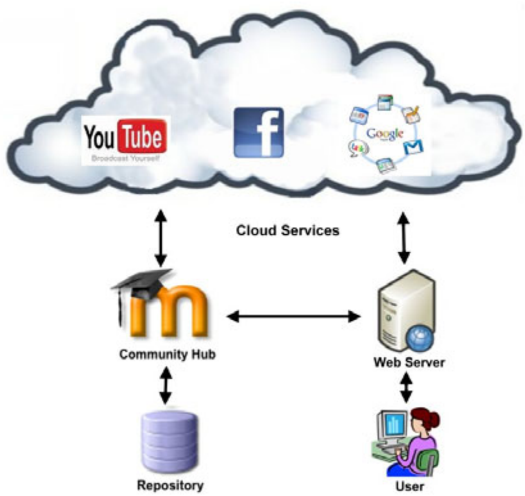

Fig. 1. The components of the platform

This platform functionality is provided by Google, Youtube, and Facebook are used to interact and manipulate the data retrieved from the cloud services. In the following, more details will be given for each component in the platform.

The Moodle web servier is to provide learning for registered learners where they can access course materials, provided and maintained by teachers. On the other hand, if course materials have a video then it can be hosted in YouTube web site. YouTube allows users to post videos, watch those posted by others, post comments in a threaded-discussion format. YouTube is increasingly being used by educators as a pedagogic resource.

We take advantage of single sign in on the Moodle's login page, when login the Moodle site, while also login self Facebook, as the Fig. 2 show. For example, we use Facebook as our walled garden social network- can add News Feed, message each other, etc. and so it draws them to the Moodle site (making it more likely that they will check out school/course information). So that if a teacher post new information or update his own materials, students browse themselves Facebook, at the some students also get the information.

The PLE also can be implemented for learner to build his own to set and achieve his learning goals. The PLE provide with learning and collection resources that include friends, teachers, and people in the same community network. When they produce new content, it automatically gets delivered to you, allowing learner to tap their knowledge. Many educators believe that the act of creating content is a valuable learning exercise, helping develop a deeper understanding of the subject matter and the tools used to create that content.

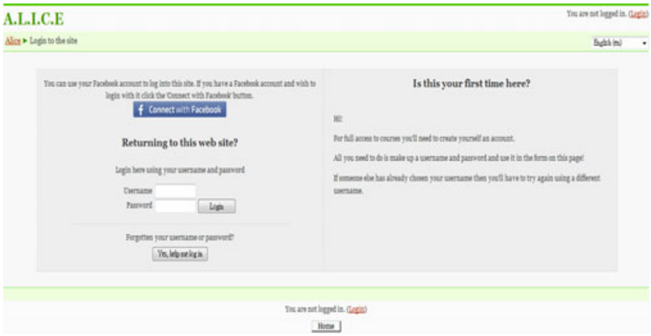

Fig. 2. The single sign in to PLE

6 Conclusion

This article presented a mashup personal learning environment for user. This solve the information isolation of learning communities, such as, learners that have certain social relationships will likely want to share their learning resources with their community.

We built a mashup personal learning environment which combines a wide range of services to create an interactive tool for education based on services available in the cloud. This paper offers reliable and scalable cloud-base services for E-learning platform. The platform utilizes constructivist pedagogical approaches to learning under the personal learning environment.

We improve the availability and scalability of E-learning platform. This set of technologies has clear potential to distribute applications across a wider set of devices. In this paper we verified that cloud computing application technologies can be exploited to build the next generation of platform and scalable data storage E-learning systems to provide learning.

However, the cloud raises a range of important policy issues, which include issues of privacy, security, anonymity, telecommunications capacity, government surveillance, reliability, and liability, among others. These will have to be worked out for the cloud to gain popularity and wide acceptance.

References

1. Brown, S.: From VLEs to learning webs: the implications of Web 2.0 for learning and teaching. Interactive Learning Environments (2008)
2. Drachsler, H., Hummel, H., Koper, R.: Identifying the Goal, User model and Conditions of Recommender Systems for Formal and Informal Learning. Journal of Digital Information 10, 4–24 (2009)
3. Garg, N., Weber, I.: Personalized, interactive tag recommendation for flickr. In: Recommender System 2009, pp. 67–74. ACM, New York (2009)
4. Harmelen, M.: Design trajectories: four experiments in PLE implementation. Interactive Learning Environments 16(1), 35–46 (2008)

5. Khan, B.H.: Learning Features in an Open, Flexible, and Distributed Environment. AACE Journal 13(2), 137–153 (2005)
6. Al-Zoube, M.: E-Learning on the Cloud, International Arab. Journal of e-Technology 1(2) (June 2009)
7. Thomas, P.Y.: Cloud Computing: A potential paradigm for practising the scholarship of teaching and learning. Instructional Designer Educational Technology Unit Centre for Academic Development University of Botswana
8. Teo, C.B., Chang, S.C.A., Leng, R.G.K.: Pedagogy Considerations for E- learning (2006), http://www.itdl.org/Journal/May_06/article01.htm (retrieved October 10, 2008)
9. Kwan, R., Fox, R., Chan, F., Tsang, P.: Enhancing Learning Through Technology: Research on Emerging Technologies and Pedagogies. World Scientific, Singapore (2008)
10. Richard, N.: The Tower and the Cloud. Educause (2008)
11. Severance, C., Whyte, A.: The coming functionality mash-up in Personal Learning Environments. Interactive Learning Environments 16(1), 47–62 (2008)

Research on Recognition and Mobile Learning of Birds Base on Network under the Condition of Human-Machine Collaboration

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Abstract. In this article, a new method used for birds' recognition under the condition of Human-machine Collaboration is proposed. By the combination of this method and network interaction, a new model of effective Mobile Learning is built. This system uses mobile Internet technology to collect data. Through the steps of recognition, classification and process to the data, Web Server provides online services in the form of Data Reports and Streaming Media. With the sorted images and surveillance video, people completed the finally recognition work. Meanwhile, they can experience the convenience of Mobile Learning. The proposed system has solved the problem about accuracy and efficiency in the field of bird recognition. Moreover, the system has evolved a Mobile learning new model which provides a better taste of mobile interaction.

Keywords: Human-machine Collaboration, Mobile Learning, Bird Recognition.

1 Introduction

With the deteriorating ecological environment, nearly 2000 years, statistics show that 139 bird species disappear from the earth. One third of the extinction is happened in last 50 years. [1] Birds have great activities on the role of maintaining ecological balance. The growing extinction of bird species will profound a wide range impact to the environment, agriculture and human society, then cause ecological problems.

In response to the abovementioned problems, we should deepen the study of birds. Traditional birds' recognition has a serious of problems involving large processing data, inefficient tracking and untimely data fetch. A concept of human-machine cooperative recognition of birds is proposed. Through the recognition to pictures, video and sound, the efficiency of bird recognition can be greatly improved. Meanwhile, the M-Learning data obtained is preprocessed by the collaboration between man and machine. It has changed the formal interactive mode. In addition, once AR and WebGL technique based on 3D network are used in the new model of M-Learning of bird, it will bring technological innovations for Mobile Learning.

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2 System Constitution

First, data collected by the remote monitoring stations automatically been identified and classified by server. Then the processed image data and audiovisual media are released to the Website. Through exploring real-time sorted pictures and surveillance video, people complete the final recognition work and Mobile Learning.

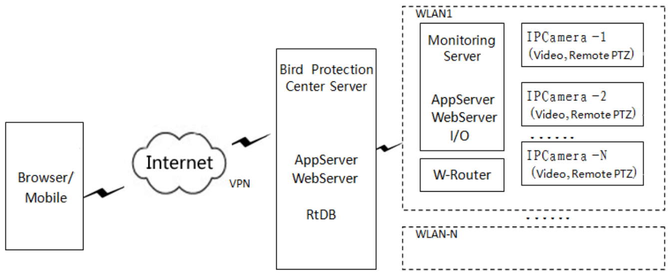

Fig. 1. System logic diagram

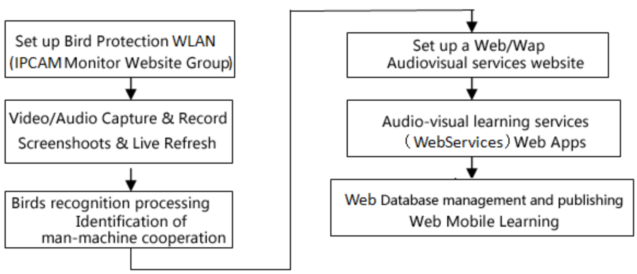

Fig. 2. System work flow chart

Through image preprocessing, feature recognition and classification base on SVM decision tree, Recognition and Classification Module deals with the collected image data. In the Collaborative Monitoring Module, by accessing to the server, PC-side gets video and audio surveillance data. Through the Internet, 3G or WAP network visiting, Mobile terminal acquire the ability of remote control monitoring. Using the data handled by two modules below, user can do the M-Learning interactive activities.

3 Image-Based Automatic Recognition and Classification

Image feature extraction and analysis is to enable the computer to understand and identify the image content according certain degree of image feature. Classification decisions mean the way to develop classification criteria by computer training with the use of feature vectors acquired from feature space. After that, identify the object to some category according to the standard use of some methods. [2]

Fig. 3. Image-based automatic recognition and classification flow chart

3.1 Image Preprocessing and Automatic Recognition

Due to the diversity in image capture conditions, like Lighting, angle, equipment, image obtained exist a certain difference in quality. For reducing differences between the same and enhancing differences between different species, some measures must be taken before feature extraction is engaged. Common image preprocessing ways are light compensation, remove background and normalizing Image.Main methods of Automatic Recognition are Colour, Shape and Texture Extraction. Colour is suitable for coarse sort and higher classification rate. For birds with similar colour, Shape Extraction is powerful for further breakdown. Feathers of birds have strong texture characteristic. Its expression is more abundant, and the recognition rate is higher.[3]

3.2 Birds Image Classification Base on SVM Decision Tree

The Support Vector Machine proposed by Cortes.C and Vapnik.V is a new machine learning methods based on statistical learning theory. According the best compromise between the complexities of limited sample information and learning ability, it received the best generalization.[4] Combining feature extraction and analysis selection, making detail design for hierarchical classifier, a SVM decision tree classification suggestion with prior knowledge is proposed. The proposal is based on the level decomposition, and is divided into four classifiers. [5]

(1) Special color Classifier

By observing histogram, From Larus relictus image in Fig4.(2), although there is plenty of pixel of color weight H accounted between 0.5-0.6, because its color purity of S is too low, so the image doesn't show blue-green color. We determine the final range of blue-green is $0.3 \le H \le 0.55$ $S \ge 0.3$ $V \ge 0.13$ after extraction experiments. Threshold percentage of 1%, and greater than 1% said the existence of blue-green in this graph. As is Fig4.(1) shown. Otherwise, there is no blue-green, compared to other birds.

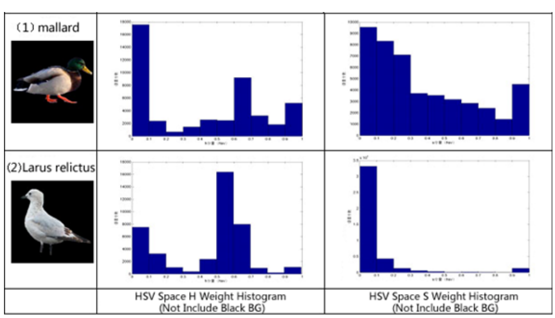

Fig. 4. Birds color histogram

(2) Color Statistics Feature Classifier

It is mainly count the Color Mean and Variance in bird images. We use low-level color moment for further divide to the birds. [6] Through the learning training for total 6 feature of first and second moment from 3 channel of image, Color statistics Feature Classifier constitute the SVM classifier. Test image is converted to HSV color space, then calculate the non-background HSV 3 channels and variance when doing classification. It is sorted by SVM classification.

(3) Shape Classifier

It mainly extracted the aspect ratio and density of bounding rectangle of birds.[6] If the aspect ratio of bounding rectangle feature is extracted, further subdivide to birds can be engaged. If the aspect ratio of bounding rectangle is consistent after the classification by color feature classifier, density of mean and variance of bounding rectangle to individuals of all species of birds is available. Experiments show that the density parameters can be extracted for further subdivision, and achieve better results.

(4) Texture Classifier

This classifier is the bottom classifier, will achieve the final classification of birds.

Wavelet texture feature classification: The image was 4 layers decomposed using DB2 wavelet in this article. Each sub-band output image was received after the image had been decomposed. Doing the Feature value extraction for 16 sub-bands image, calculating the average energy and variance, doing the texture extraction separately according 3 channel of color image, we extracted total 96 texture features.

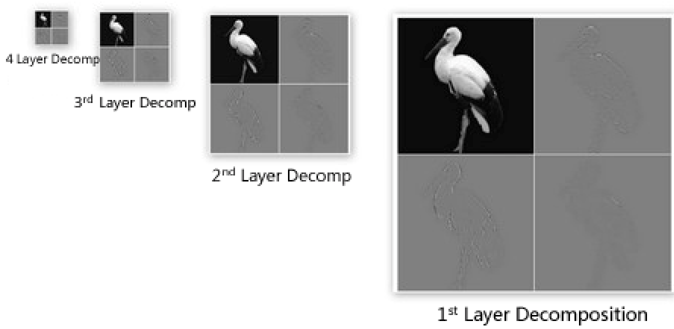

Fig. 5. 4 layers bird Image decomposition diagram

4 Monitoring and Recognition under the Condition of Human-Machine Collaboration

4.1 PC-Side Video Surveillance and Recognition

Service Website has collaborative monitoring function.

Live video surveillance: Access to the child through the monitoring center sites, user can control camera's Zoom and Rotate using video surveillance platform in child monitoring sites to achieve real-time monitoring function.

Video and image capture: Record the video and image information obtained by the need in anytime or specified time. These data daily recorded can be used for the future subsequent data processing.

The Minjiang River Estuary birds' surveillance & early warning project has been chosen for example in this paper.

Fig. 6. Web Server user interface

4.2 Mobile Phone-Side Video Surveillance and Recognition

WAP standard video system is divided into two parts; one part is web application program which is responsible for frames taking. Another part is WAP website showing image frame. As mobile phone' handling capacity is limited compared to PC. The main processing steps are placed on the application server; WAP clients reduce the stress by doing this, so that it can quickly refresh the video image processing.

Mobile PTZ control is consists of a control file and a windows service program. By the writing of control commands to the control file through WAP website, windows service program real-time monitoring the control file. Once it is changed, they can immediately be read and execute.

5 Mobile Learning under the Condition of Human-Machine Collaboration

Mobile Learning: Relying on the mature technology of wireless computing, Internet technologies and digital multimedia technology, through the use of mobile computing devices (such as mobile phones, tablet PCs), Students and teachers can have the flexibility to conduct two-way communication in any time or any place.[7]

5.1 New Model of Mobile Learning under the Condition of Human-Machine Collaboration

(1) Human-machine collaboration used in Mobile learning

For regular Mobile learning, learning materials generally do not been preprocessed through a procedure of Human-machine collaboration. While during the period of Mobile learning of bird in this system, data is processed through online collaboration.

After the automatic recognition and classification of pictures, data service is provided on website in the form of sorted pictures. By the 3G, WAP or Wi-Fi access, data is identified and classified once again by learners. Through the human-machine collaborative process, image data finally been used as M-learning materials.

The site provides query and playback functions after video/audio data are classified and saved. It brings great convenience for data searching in any time and any place for M-learning. It also supplies an important way for human-brain recognition and on-line decision of system administrator in the way of real-time, timing or event trigger.

(2) Mobile information interact

Server automatically records the activity data of some type of bird in certain period of time from monitoring station. The relative report handled will be submitted to the website. Learner can accomplish mobile interaction by logging the site and operating in the corresponding function areas. People not only can systematically get the report about dynamic develop situation of some type of bird, but also save much time when engaging M-learning. It also reflects the real-time and timeliness of Web interactivity. The interaction procedure of mobile information is presented following:

Select key word "year" and "bird name" for inquiry first, then get the statistical data. Shown in Fig7.below:

Fig. 7. Inquiry and Statistical data interface

According to the statistical results of the machine, learner can examine the image data in corresponding time. Through visual observation and analysis, user can fill out the form and submit to complete the investigation on bird diseases.

Fig. 8. Report submit interface

5.2 Mobile Learning Based on 3D Network

For traditional Internet, information composed is present in the form of 2 dimensional elements. The interactive way basically also is in the form of 2 dimensions. While 3D network is a three-dimensional interactive space, the page elements is not only expressed in tridimensional way, but rendered and generated by GPU real-time calculation. New model of Mobile Learning based on 3D network will be an evolution of Mobile Learning in technology. [8]

(1) WebGL technology for Mobile learning

WebGL is a cross-platform, open source API; using it directly in the Web browser, we can display 3D scenes and models in web page. It has two advantages: without having to install any browser plug-ins, it not only can directly call the underlying graphics hardware acceleration for real-time graphics rendering, but also implemented through a unified, standard, cross-platform OpenGL interface. By mobile accessing the web page programmed with WebGL technology, it can improve the immersive feeling and greatly arouse the enthusiasm of learners when doing virtual interaction. [9] The 3D interactive web page rendered by WebGL is shown in Fig9.(1).

(2) AR technology for Mobile learning

With the help of computer graphics technology and visualization technology, AR(Augmented Reality) technology can mix physical reality with virtual images or text message. It has the new properties of combination of virtual and reality, real-time interaction and 3D registration. In mobile learning process, after learners click the target in surveillance video, through a series of AR technology processing, Overlay displaying virtual note contents or 3D animation stuffs next to that bird, it can help learners to acquire knowledge of birds better. Finally, by the brows of data in 3D web page form by the wireless transmission, learners complete Mobile learning. AR-tech embedded web page for virtual interaction is presented in Fig9.(2).

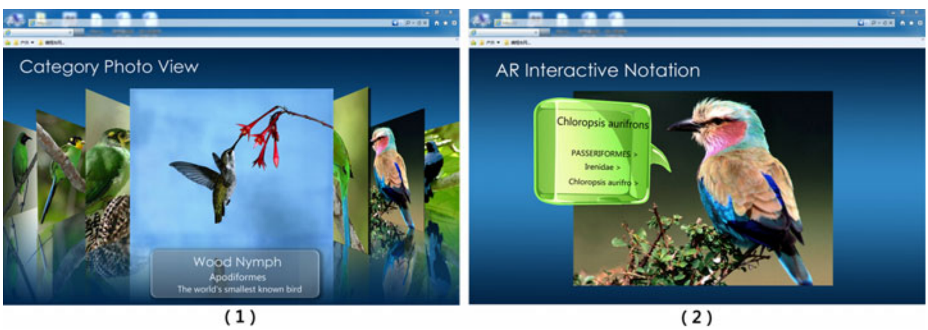

Fig. 9. The 3D interactive web page and AR-tech embedded web page

5.3 Advantages and Effects of New Model of Mobile Learning

First of all, many fussy and time-consuming preprocessing works of M-learning materials data are handled by machine under the condition of Human-machine collaboration. Man only participate in data collation, validation and make real-time, timing or event trigger types of decision. Moreover, preprocessed learning material (statistics, sorting records, or screenshots) are rich variety and classified scientifically. Online collaborate process either convenient or efficiency for M-Learning.

Second, Mobile Learning based on 3D network has change the bald and flat original interactive way. It had broken the space limitations in visual dimension. It had brought the interactive way of Mobile learning into the real 3D space era. In addition, with the help of AR technology, introducing virtual 3D notation into real scene, it can improve the learner's interest better. It also can meet the goal of Edutainment which Mobile Learning always pursuing.

6 Conclusion

On the one hand, a new concept of Human-machine cooperative recognition is proposed. Under the guidance of this concept, the Mobile learning efficiency of bird has been greatly increased, the recognition accuracy and authenticity of birds has been improved, and the content and types of Mobile learning materials are enriched. On the other hand, with the help of WebGL web page real-time rendering and AR interactive virtual notation these two technologies, new learning model break the limitation of interactive dimension. People can interact in distance using their imagination more freely. This new Mobile Learning model not only improves the learner's interest but also meet the goal of Edutainment which Mobile Learning always pursuing. In addition, the study on recognition and Mobile Learning of bird has far-reaching practical Ecological Protection significance.

References

1. Zhu, L.: Bird watching Tourism and the Protection of Birds. Journal of Henan Business College 21, 65–66 (2008)
2. Huang, Z.: A Study of Feature Extraction Technique Based on Color Image & Plant Classification. University of Science and Technology of China Press, Hefei (2007)
3. Selouani, S.-A., Kardouchi, M., Hervet, E., Roy, D.: Automatic birds recognition based on autoregressive time-delay neural networks. In: Congress on Computational Intelligence Methods and Applications (CIMA 2005), pp. 1–6 (2005)
4. Vapnik, V.: The Nature of Statistical Learning Theory, 2nd edn. Springer, Heidelberg (2000)
5. Seppo Fagerlund, S.: Bird Species Recognition Using Support Vector Machines. EURASIP Journal on Advances in Signal Processing Volume (2007)
6. Burges, C.J.C.: A tutorial on support vector machines for pattern recognition. Data Mining and Knowledge Discovery 2, 121–167 (1998)
7. Wei, H., Di, J.-q., Sun, H.-j.: Research and Practice of the M-Learning Theory, Changsha, vol. 31, pp. 135–141. Computer Engineering & Science Publisher (2009)
8. Zhao, S.: Design and Development of Mobile Learning System. Jilin University Press, Changchun (2009)
9. WebGL Wiki introducing page, http://www.khronos.org/webgl/wiki/Main_Page

Blue Sky Flying Camp — A Relief Project to Facilitate Pupils' Understanding Concerning Aeronautics

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Abstract. The flood 88 of 2009 in Taiwan caused catastrophic effects on the residents in the southern part of the island. This project is one of the efforts and we have designed and carried out a hands-on curriculum as part of the therapeutic measures to the students that suffered from the flood. Our results show that, from these long-term activities, the facilitation of our pupils concerning aeronautics and the therapeutical outcomes are significant.

Keywords: aeromodeling therapy, curriculum design, flying course, hands-on.

1 Introduction

The flood 88 of 2009 in Taiwan caused catastrophic effects on the residents in the southern part of the island. Our government is trying very hard to make a relief to the victims from this natural disaster. This project is one of the efforts and we have designed and carried out a hands-on curriculum [1] using aeromodeling [2], to raise pupils' interest in aeronautic and to facilitate their attitude toward science. Our curriculum was joined with counseling working personnel as part of the therapeutic measures [3] to the students that suffered from the flood. This project fulfills one of the main goals of the contemporary nine-year continuous curriculum to improve our students' learning capabilities and science literacy. In order to achieve the goal, we need to facilitate students' process skills through hands-on activities. In this hands-on curriculum design, we utilize hand launch glider (HLG) as an example [4, 5].

2 Curriculum Design

Before the pupils design and construct their own HLGs, Aeronautical Teachers (Mentors) demonstrates radio controlled (R/C) models allowing pupils exposure to the model aerodynamics [6]. Digital Flying Simulator (DFS) is employed as well to assist pupils with more hands-on experience on the flying control deck. Figure 1 shows the concentration of the pilot with radio controller. To strengthen pupils'

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capabilities in comparison and observation, various static models are also demonstrated allowing pupils to touch. The tasks for pupils to perform in the teaching and learning processes are as followings: 1. draw up her/his design, 2. take measurements and construct the design, 3. adjust and control the HLG, 4. trial and error, Figure 2 shows our pupils launching their artifacts to fly under blue sky, and 5. readjust and name their artifacts. We emphasize on the trial and error since it is one of the key points to improve their own HLG designs.

Fig. 1. DFS in action with our pupils

Fig. 2. Pupil's trial & error with their HLG

3 Outcomes

Our results show that, from these long-term (February 2010 to June 2010) activities, the facilitation of our joined students' can be summarized as followings: 1. aeronautics content knowledge, such as wing types for the left, air flow for flying control, 2. the measurement and adjustment of the center of gravity (CG), 3. applications of the flying crafts, such as disaster relief and surveillance, 4. interest in aeronautics, and 5. the enjoyment from collaboration. Also, the interview results show our flying camp offering pupils a self-learning context and it can influence their life-long learning endeavor. The supports from pupils' school officials also play an important role to the success of these activities.

Aeromodeling can play a role in the stress control therapy particular in this relief project (HTTP：/stress management radio control aeromodeling hobby for stress management therapy, stress management therapy, psychology professors.htm). The relief effort was taken in part by a colleague and senior undergraduate with a specialty in the children counseling. Our relief team members spoke with our campers and assist some of them unfortunately with great losses and/or with physiological discomfort with their classmates or family. From our observation, most of the conflicts could be resolved at the scene and/or, with in depth counceling conversations, the peaceful mood of the camp could maintain afterward.

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References

1. Carin, A.A., Sund, R.B.: Teaching science through discovery, 6th edn. Merrill Publishing Company, London (1989)
2. Alcorn, A.L.: Modeling behavior: Boyhood, engineering, and the model airplane in American culture. Doctoral Dissertation (2008), http://proquest.umi.com
3. Yerlikaya, I.B.: The effect of hope training program on primary school children hopelessness level based on cognitive –behavioral approach and hobby therapy. Doctoral Dissertation (2006), http://www.egitim.ankara.edu.tr
4. Lee, S.J., Farh, L., Lee, W.C.: A hands on curriculum design for Nine Year Continuous Curriculum reform- using hand-launch glider as an example. Curriculum and Teaching Quarterly 9(1), 81–98 (2006) (in Chinese)
5. Chiu, B.S., Lee, W.C., Farh, L., Lee, S.J.: Blue sky flying camp for creativity: the design and practice. Science Education Monthly 332, 17–24 (2010) (in Chinese)
6. Usher, B.: Retirees Aeromodeling! – Interested? Alexandrina Center for Positive Aging. Newsletter, 7 (May 2009)

Peer Feedback in Online Writing System

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Abstract. This study proposes a prototype design of an online writing system. In this system, it consists of five different activities, including two key elements: peer feedback and “feedback of feedback”. Through the online writing system, we hope the interaction between reader and writer can improve their writing quality and motivation in writing. Two key elements can foster the development of creativity and critical thinking for students’ language skill.

Keywords: Peer feedback, Feedback of feedback, Peer writer, Peer readers.

1 Introduction

In writing activities, most teachers are usually difficult to review student’s articles and give any grades. Besides, it will take a lot of time to give feedback on student writing for teachers. And these feedbacks are often based on the teachers’ viewpoints. Therefore, students only attach importance to their writing’ grades, rather than teachers’ comments. Students had low interest in writing and their writing quality is hard to improve. This results in poor writing ability and affects individual creativity and the development of critical thinking.

Recently many studies focus on how to use peer feedback to support writing activities (Hu, 2005; Rollinson, 2005). According to the aforementioned lack of writing activities, many researchers have put peer feedback into writing systems, which only include the receiving of student feedback without real interaction and cooperation on feedback among peers, such as the evaluation of reader feedback.

Therefore, the purpose of this study is to provide students an online writing system, which will integrate peer feedback into writing activities to help peer writers revise their writing.

2 Peer Feedback

Topping (1998) had defined the meaning of peer feedback: A group of students work with each other to give a qualitative evaluation on peer’s work through words or verbal interaction or give a quantitative evaluation through sets of scores, rankings, etc.

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The study of Rollinson (2005) suggested that student feedback can get students more encouraged and inspired than teacher feedback does or at least student feedback can offer a new interaction among students, which is different from the traditional interaction between a teacher and students. The interaction between writers and readers can encourage dialogue and train communicative skill (Villamil & Guerrero, 1996). This interaction created a two-way feedback approach, which means peers can play as readers and writers in turn. Such an approach provides students an opportunity to learn how to give peer students feedback and understand the advantages of feedback provided by other peer readers (Mendonca & Johnson, 1994). Hedgcock and Lefkowitz (1992) found that the final revision of drafts received peer feedback obtained higher achievement in overall scores than those received teacher feedback.

According to the aforementioned peer feedback studies, their results all suggested peer feedback is effective on helping students learn peer interaction. In addition to the adding of peer feedback in our designed writing system, the mechanism of "feedback of feedback" between writers and readers will be also included to improve the quality of feedback. Students in the online writing system will play not only the role of a writer, but also a reader and constructive reviewer.

3 Design of an Online Writing System

The online writing system consists of five steps (see Figure 1). Each step will have a different writing activity conducted. Step1: All students have to finish their first draft

Fig. 1. The online writing system consists of five steps. Peer feedback and " Feedback of feedback" are two key elements.

in the system before next writing activities. Step2: The activity can be divided into two parts: one is the individual peer reader feedback, and another is a group version of feedback by integrating all of the peer feedback in a group based on a common consensus via group discussion. The team members independently give their feedback and scores of the other peer student writing work. Then the system will aggregate scores first and rank the pieces of student writing based on the aggregated scores. To the end, all team members discuss the overall ranking of student writing through different points of view. Before sending the results to the system, they must reach a common consensus on the ranking of student writing. Step3: A student writer has to evaluate feedback received from the other peer readers. Evaluation results will be sent back to the system. Step4: The writer can modify their own writing again by comments received from readers or new ideas generated by himself/herself. Step5: All of students writing will be published in public. From the perspective of readers, each reader in the online writing system will be evaluated according to the quality of their feedback on the work of peer writers and the acceptance rate of their feedback will be displayed in the system.

4 Features of the System Design

The study provides a prototype of an online writing system with the functions of peer feedback and "feedback of feedback" into the writing activities. The functions are also key elements. All students can learn to be good writers, readers and reviewers from it. In order to promote the interaction between peers, they can help each other's writing.

Peer writers can learn reader comments from different angles and express writers' reflection in their revised articles. They can be each other's teacher, recorder and information-sharer. Through conflicts of opinions and ideas, there will be some interaction between peer writers and peer readers. During the interaction, they can reach a consensus and develop their own opinions. The system will allow a good circulation between peer readers and peer writers. Different from the past where students can only play the role of writers, now students not only play as a writer, but also as a reader. Besides, they can provide more constructive comments for writing improvement. So they are also reviewers.

On the one hand, the points of view expressed by readers will become increasingly obvious. More efforts will be required for peer readers to make their comments accepted by peer writers. Then, they can recognize their own *advantages* and disadvantages in their writing, and promote a sense of ownership of their writing (Richards & Rodgers, 2001).

5 Conclusion

This research provides the design framework for online writing system which is an excellent cycle between peer readers and peer writers. As a result, peer feedback in the online writing system may improve their interaction and motivation in writing. The design of peer feedback and "feedback of feedback" is to provide students opportunities to become a good writer, reader and reviewer in the future. Currently, the online writing system is under construction, which will contain the five activities mentioned above. An evaluation of the system will conducted in the future with the hope of peer feedback can help students develop individual creativity and critical thinking.

References

1. Hedgcock, J., Lefkowitz, N.: Collaborative oral/aural revision in foreign language writing instruction. Journal of Second Language Writing 3, 141–163 (1992)
2. Hu, G.: Using peer review with Chinese ESL student writers. Language Teaching Research 9, 321–342 (2005)
3. Mendonca, C., Johnson, K.E.: Peer review negotiations: revision activities in ESL writing instruction. TESOL Quarterly 28(4), 745–769 (1994)
4. Richards, J.C., Rodgers, T.S.: Approaches and methods in language teaching, 2nd edn. Cambridge University Press, Cambridge (2001)
5. Rollinson, P.: Using peer feedback in the ESL writing class. ELT Journal 59, 23–30 (2005)
6. Topping, K.J.: Peer assessment between students in colleges and universities. Review of Educational Research 68(3), 249 (1998)
7. Villamil, O.S., de Guerrero, M.C.M.: Peer revisions in the L2 classroom: social cognitive activities, mediating strategies, and aspects of social behavior. Journal of Second Language Writing 5(1), 51–75 (1996)

Designing a Mixed Digital Signage and Multi-touch Interaction for Social Learning

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Abstract. Recently, digital signage has been getting popular in public and private environments, such as retail stores, museums, corporate buildings and even campuses. Digital signage with large and vivid LCD display is typically used as public information exhibition. In spite of growing popularity of digital signage, the lack of interactive capabilities of conventional digital signage prevents students from further exploring and sharing information on the display for learning purpose. Multi-touch interaction with large display, on the other hand, provides natural and intuitive interfaces that can potentially attract students to engage and play in public space. However, how to design a multi-touch application to engage students in a natural and playful learning environment still remains less unexplored research area because it requires developing a new innovation of hardware and software complexity.

In this paper, we present a mixed digital signage and multi-touch interaction environment that can encourage students engaging in a watch-and-play style social learning at a public place. The system was designed and developed by transforming two VIZIO 52-inch LCD displays into a multi-touch social learning space with little extra cost. The two LCD displays are designed to function as a typical digital signage to show interesting news and video to attract students outside our department. Students then can point their fingers on displays and turn the system into a multi-touch Web-based rich multimedia learning environment.

To realize the key factors of student engagement and satisfaction with our system, we developed a user study model based on the updated D & M IS Success Model and the Technology Acceptance Model. The integrated model contains six constructs: system quality, information quality, interaction quality, perceived usefulness, perceived ease-of-use, and user satisfaction. Empirical result from 145 participants indicates our proposed system is very promising. However, user study on our research model also validated some system design problems such as system and interaction quality must be solved to make the proposed system as a great learning aid in the foreseeable future. The evaluation model we developed can be used as an evaluation tool to provide useful guidelines for developing more advanced social learning system. The software architecture, implication, and future work were described.

Keywords: Multi-touch, Digital Signage, Social Learning.

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Building a Multi-touch Tabletop for Classrooms

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Abstract. This paper aims to build a compact multi-touch tabletop that can be easily integrated with a normal classroom desk to become a student touch desk. Various state-of-the-art multi-touch technologies are investigated. Based on the analysis of their multi-touch quality, physical characteristics and application requirements, the projected capacitive touch (PCT) technology based on ITO coatings is selected. To provide high quality display, a slim LED television is used and integrated with the PCT panel. A 32-inch dual-touch tabletop has been implemented and shown at BETT 2011. Compared with the potential competing systems such as 3M 32-inch multi-touch displays, this tabletop is more compact and its thickness is only half of the 3M display thickness. The contrast ratio and brightness are better. The cost of the tabletop hardware is about 1/4 of the price of a 3M 32-inch multi-touch display. The tabletop is being used in a secondary school and has received positive feedback from users.

Keywords: Multi-touch tabletop, multi-touch student desk, multi-touch technologies.

1 Introduction

A multi-touch display device provides a mechanism for users to interact with the display directly using their fingers, rather than indirectly with a cursor controlled by the mouse. Users need not to learn how to manipulate any intermediate devices. This allows users to concentrate on what they want to accomplish and human computer interactions become more efficient. The history of touch can be traced back as early as the late 1960s. However, touch technologies had not caught great attention until the appearance of multi-touch technologies in recent years. In 2005, Jeff Han published his multi-touch sensing work based on frustrated total internal reflection [1]. Unlike older touch-screen interfaces, his technology can recognize multiple points of contact. In 2007, Microsoft Surface was announced [2]. By the use of gesture recognition, it allows a user, or multiple users, to manipulate digital content such as photos in a very intuitive manner. Along the multi-touch stream, Apple developed iPhone and iPad. The wide popularity of Apple's multi-touch products has announced the beginning of a new era and multi-touch is revolutionizing the way people interact with computers.

Multi-touch technologies are stepping into schools to enhance the learning experience. Lots of traditional whiteboards have been replaced by interactive touch whiteboards. To make the learning process more interactive and interesting, student desks

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become the next facility to be upgraded. Student desks have been used as purely supporting furniture for hundreds of years. However, the tops of the desks do have the potential to be used as interactive display surfaces. Till today, quite a few touch tables have been developed, such as Microsoft Surface, U-Touch table [3], TouchTable®[4] and GesTableTM [5], etc., but most of them are designed for group discussion. Their structures and dimensions are not suitable to be used as interactive learning devices in a classroom environment.

It is not easy to design an optimal touch desk suitable for all classrooms. Many factors have to be taken into consideration, from physical characteristics to hardware capabilities, contents and costs. Instead of customizing a touch desk for schools, a more practical and flexible solution is to design a compact multi-touch display tabletop that can be easily integrated with a normal classroom desk to become a student touch desk. According to international standards on the functional sizes of tables for educational institutions [6], the size of the tabletop should be about 60.0 cm × 40.0 cm (L × W), which is close to the size of a 32-inch HD display. To support multi-touch (at least dual-touch) for this size, most existing systems use the optical touch technology [7], which encapsulates both the infrared light source and two cameras inside a narrow frame. Unfortunately, this frame not only makes a visually pleasing borderless appearance (full-size-plane, as Apple iPhone and iPad) very difficult to achieve, but also causes maintenance issues. Another more promising approach is to use PCT technology. Recently, 3M showed its 32-inch multi-touch display prototype at CES 2011 [8]. This multi-touch display is based on PCT and LCD technologies. Compared with LED display, the size of LCD display is usually bigger and the contrast ratio is lower. 3M 32-inch multi-touch displays are not available on market yet. Judging from its 22-inch multi-touch displays, the transparency of 3M PCT panels seems not very good.

In this paper, we aim to build a compact and visually pleasing multi-touch display tabletop that can be easily assembled to become a student touch desk. Based on the survey of state-of-the-art multi-touch solutions, a 32-in dual-touch PCT module based on ITO coatings is selected. A customized slim HD LED television is used as the display module, which is integrated together with the PCT touch module by a specially designed frame. The tabletop has been successfully implemented and demonstrated at BETT 2011. Compared with the competing systems such as 3M 32-inch multi-touch displays, this tabletop is more compact and its thickness (3.4 cm) is only half of the 3M display thickness (6.68 cm). The contrast ratio and brightness are better. The cost of the tabletop hardware is less than $1200, which is about 1/4 of the price of a 3M 32-inch multi-touch display.

The paper is organized as follows. Section 2 reviews state-of-the-art multi-touch tables, displays and relevant touch technologies. Section 3 introduces the design and implementation of a 32-inch dual-touch tabletop. Section 4 gives the conclusion.

2 Related Multi-touch Technologies and Systems

Numerous multi-touch tables and displays have been developed. The underlying touch technologies include resistive, optical, LCD in-cell optical, surface acoustic wave, and project capacitive, etc. In this section, we briefly introduce some of the popular multi-touch technologies and analyze their advantages and disadvantages.

2.1 Multi-touch Technologies

Resistive Touch. A resistive touch panel is composed of two thin, conductive layers separated by a narrow gap. When an object, such as a finger, presses down on a point on the panel's outer surface, the two metallic layers become connected at that point. This causes a change in the electrical current, which is registered as a touch event and sent to the controller for processing.

Resistive touch panels are low cost and resistant to environmental factors such as dust, liquid and humidity. They have been widely used in outdoor kiosks, instruments and restaurants. However, their application in portable consumer electronic devices is not successful compared with PCT panels. The possible reasons include:

- Sensitivity. Touch information is generated by pressing, not by "sensing". As a result, the interaction seems not very sensitive and fluent, especially for gestures such as zoom, rotate and page flip.
- The bezel. Resistive touch panels need a Bezel design to cover the circuits of their touch-and-control panel boards. A visually pleasing borderless appearance, i.e. full-size-plane, is difficult to achieve.
- Optical transparency. The transparency of a resistive touch panel is around 80% whereas that of a PCT panel can be 92%. This results in significant difference in display quality. PCT display is much more visually pleasing.

According to our knowledge, the largest size of today's multi-touch resistive panels is 23 inch. They are used in the Acer Aspire z5761 all-in-one desktop PC [9].

Optical Touch. An optical touch system uses infrared light and sensors to track the user's fingers. Many optical multi-touch techniques have been implemented, which can be categorized into three groups: integral approaches, optical frames, and LCD in-cell optical.

Integral Approaches. "Integral" means that optical sensing modules are tightly integrated with display modules. Typical techniques under this category include the Frustrated Total Internal Reflection (FTIR), Diffused Illumination (DI), Laser Light Plane illumination (LLP), Diffused Surface Illumination (DSI), and LED Light Plane (LED-LP) [10].

To integrate the optical sensing module with display module, the mechanical design is more complex and the whole product is usually quite bulky. Other disadvantages include the computational demands of processing high resolution images, susceptibility to adverse lighting conditions and problems of motion blur.

Optical Frames. Both the infrared light source and two cameras are encapsulated inside a narrow frame, which can be easily put together with a display device such as monitor, television or projection screen. Compared with the integral approaches, optical multi-touch frames are more compact, much easier to produce and deploy. Due to these obvious advantages, they have been widely used in touch walls, whiteboards, kiosks, and other large-sized interactive display products [3, 7].

In recent years, many advanced algorithms have been implemented to enhance the performance of optical touch and make it more robust to adverse lighting condition. However, the frames make full-size-plane design impossible. When the frame is used to build a touch table, how to design an appropriate waterproofing structure is another challenge. Furthermore, any object near enough to the display screen may block the infrared light and cause unexpected errors.

LCD In-Cell Optical. This is an emerging technology. In such a touch display system, the infrared sensors are made part of LCD display, which allows the surface of the display to sense, or "see," what is on top of it without using a camera [11, 12].

Surface Acoustic Wave (SAW) Touch. This technology uses ultrasonic waves that pass over the touch screen panel. When the panel is touched, a portion of the wave is absorbed. This change in the ultrasonic waves registers the position of the touch event and sends this information to the controller for processing. Traditionally SAW touch products only support single point touch. Recently Tyco Electronics demonstrated the ELO 2242L systems at ICE 2011 exhibition, based on its IntelliTouch Pro SAW multi-touch technology [13].

A SAW touch panel is composed of a piece of clear, durable, scratch resistant glass. This makes it highly durable and suitable for applications where high clarity is desired. However, the panel must be touched by fingers, gloved hand, or soft-tip stylus. Hard objects such as pens and finger nails won't work. Large amounts of contaminants such as dirt, dust and water can also interfere with the functionality of the touch panel.

Projected Capacitive Touch (PCT). PCT technology detects the change of capacitive value when the panel is touched. An X-Y grid is formed either by etching a single layer to form a grid pattern of electrodes, or by etching two separate, perpendicular layers of conductive material with parallel lines or tracks to form the grid. As the top layer of a PCT panel is glass, PCT panels are scrape-resistant, durable and robust. Another great advantage is the full-size-plane design in PCT panels' appearance. This design not only has good optical performance, but also can easily sense and operate through light touch.

Due to these characteristics, PCT technology has been widely applied in consumer electronic devices such as iPhone and iPad. For large-sized PCT panels (32 inch and above), we tested the 32 inch panels from MasTouch [14], and the panels from Zytronic [15]. They are based on ITO coatings (named ITO PCT panels) and conductive wires (named CW PCT panels), respectively.

Our experimental results showed that, for two point touch, the accuracy and stability of CW PCT panels were not as good as ITO PCT panels. In terms of appearance, ITO PCT panels have a black border whereas CW PCT panels do not have. But the transparency of CW PCT panels is lower and the embedded metal wires can be seen.

Table 1 summarizes the multi-touch technologies discussed in this subsection and gives a brief comparison. To build a multi-touch student desk that is about 32 inch and supports dual-touch, a reasonable choice is to use PCT technology. The PCT panel is basically a piece of glass, which enables the design of a compact and visually pleasing borderless appearance possible.

Table 1. Comparison of the state-of-the-art multi-touch technologies

	Resistive touch	Optical touch			SAW touch	PCT touch	
		Integral mode	Frame mode	In-cell optical		ITO coastings	Conduc-tive wires
Independent touch points >= 2	√	√	√ (2 points)	√	√ (2 points)	√ (2 points)	√ (2 points)
Panel Size >=32 inch	× (Up to 23 inch)	√	√	√	√ (Up to 32 inch)	√ (Up to 32 inch)	√
Multi-touch performance*	√	√	○	–	○	√√	○
Robustness	√	○	○	–	○	√	√
Light transparency	○	○	√	√	√	√	○
Full-size-plane design	×	√	×	√	×	√	√
Feasibility for building a tabletop	√	×	√	×	√	√	√

* The testing soft tool is the Paint on Windows 7.
Note: √ good, ○ ok, × bad, – unknown

2.2 Multi-touch Systems

Touch tables. Most of the existing touch table such as Microsoft Surface 1.0, 2.0, U-Touch table, TouchTable® and GesTableTM, etc., are designed for group discussion. Their designs, structures and dimensions are not suitable for a classroom environment.

Touch displays. Most of the existing integrated touch displays are based on optical frames. As discussed in the above, optical frame designs are not suitable to be used as tabletops in schools. 3M multi-touch displays use PCT and LCD technologies. Its 22-inch displays are too small to be used as student touch desks. The 32-inch multi-touch displays are very expensive.

3 Build a Multi-touch Display Tabletop for Classrooms

We target to build a multi-touch display tabletop, which can be easily assembled to become a student touch table. According to international standards on the functional sizes of tables for educational institutions, the size of the tabletop should be about the size of a 32-inch HD display. Other requirements include:

- Multi-touch: At least independent two point touch should be supported.
- Display size: 32 inch (diagonally) LED display is preferred.
- Display resolution: native 1920 × 1080.
- Robustness: It should be suitable for a classroom environment.
- Appearance: Full-size-plane design is preferred.

As indicated in table 1, the size of resistive touch panels is too small to be used. The integral optical touch modules are bulky and not suitable for building a tabletop. Both optical touch frames and SAW touch products have an edge border, which not only makes full-size-plane design impossible, but also results in maintenance problems. Microsoft Surface 2.0 is an integrated product. Its price is very expensive ($6,700) The only reasonable choice is PCT panels.

We tested the ITO PCT panels and the CW PCT panels, and decided to choose the 32 inch ITO PCT panel because of their better multi-touch performance and resolution. For the display part, we used a slim 32-inch HD LED television and removed its frame. A customized ABS plastic frame was designed to put the display module and the PCT module together.

The final multi-touch display tabletop is shown in Fig. 1. The tabletop is compact. It can be easily assembled to become a student touch table (see Fig. 2), or be directly used as a portable multi-touch display.

Fig. 1. Our multi-touch display tabletop is a compact and independent module: (*left*) the size is 77.4 cm × 48.1 cm (L × W) with a native HD resolution, (*right*) the thickness is 3.4 cm.

A brief comparison of our tabletop with the most potential competing sysetem 3M 32-inch multi-touch display is given in Table 2.

We demonstrated our tabletop at BETT 2011 (see Fig. 2(left)). It was very easily integrated with a normal small wooden table. Fig. 2(right) shows the integration of the tabletop with a specially designed motorized table. The touch table is being used in a secondary school and has received positive feedback from users.

Table 2. Comparison of our tabletop and with 3M 32-inch multi-touch display

	Our touch display tabletop	3M 32-inch Multi-touch display
Display technology	LED	LCD
Constrast ratio	Very high	1300 : 1
Native resolution	1920 × 1080	1920 × 1080
Number of touch points	2	10
Touch communication	USB	USB, RS232
Operating system support	Win 7	Win 7/Vista/xp, Linux
Video input	VGA, HDMI, DVI	VGA, HDMI, DVI
Physical (W×H×D): cm	77.4 × 48.1 × 3.4	75.9 × 45.3 × 6.7
Display weight	8.1 kg	TBD
Price	$1,200 (cost)	$4,900

Fig. 2. Our touch display tabletops can be easily configured as touch tables: (*left*) mounted on top of a tea table, *(right*) integrated with a motorized table

4 Conclusions

We have built a compact multi-touch display tabletop, which can be easily assembled to become a student touch table, or be directly used as a portable multi-touch display. The tabletop is composed of a PCT panel, a customized HD LED television and a specially designed frame. To build the tabletop, various state-of-the-art multi-touch technologies have been analyzed. This may be used as a practical reference when similar multi-touch display devices are to be built for schools.

References

1. Han, J.Y.: Low-Cost Multi-Touch Sensing through Frustrated Total Internal Reflection. In: ACM UIST 2005, pp. 115–118 (2005)
2. Microsoft Surface 1.0, `http://www.microsoft.com/surface/gettingstarted10.aspx`
3. U-Touch products, `http://www.u-touch.co.uk/index.php/products/`

4. TouchTable, http://www.touchtable.com/products-tt45.php
5. GesTable, http://www.gesturetek.com/illuminate/gesttable-42-lcd-multi-touch-table.php
6. ISO 5970:1979, Furniture – Chairs and tables for educational institutions – Functional sizes, http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_detail.htm?csnumber=12165
7. NextWindow products, http://www.nextwindow.com/products/index.html
8. 3M 32-inch multi-touch display, http://www.3M.com/touch
9. Acer Aspire Z5761, http://tech.sina.com.cn/pc/2011-04-09/08481711239.shtml
10. NUI Group Authors: Multi-touch Technologies, version 1.0 (2009), http://nuicode.com/attachments/download/115/Multi-Touch_Technologies_v1.01.pdf
11. Hodges, S., Izadi, S., Butler, A., Rrustemi, A., Buxton, B.: ThinSight: versatile multi-touch sensing for thin form-factor displays. In: ACM UIST 2007, pp. 259–268 (2007)
12. Microsoft Surface, http://www.microsoft.com/surface/en/us/default.aspx
13. IntelliTouch plus surface acoustic wave multi-touch touch technology, http://www.elotouch.com/Technologies/IntelliTouch/Plus/default.asp
14. MasTouch PCT panels, http://www.mastouch.com.tw
15. Zytronic PCT panels, http://www.zytronic.co.uk

Perceived Fit and Satisfaction on Online Learning Performance: An Empirical Study

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Abstract. Online learning systems (OLSs) have been widely implemented by higher education institutions to support teaching and learning by assisting instructors' and students' interactive communications. This paper integrates information system (IS) continuance theory with task-technology fit (TTF) to extend understandings of the antecedents of the intention to continue OLS and impacts on learning. Results reveal that perceived fit and satisfaction are important antecedents of the intention to continue OLS and individual performance.

Keywords: online learning, perceived fit, information system.

1 Introduction

Online learning systems (OLSs) have been widely implemented by higher education institutions to support teaching and learning [13] [26]. However, the link between the antecedences of keeping students using OLS and their impacts on learning, for example, learning effectiveness and productivity, is overlooked. This paper plans to tackle this question by integrating information system (IS) continuance theory [4] with task-technology fit (TTF) [14] to further our understandings of the antecedents of OLS continuance intentions and their impacts on learning.

Past studies have asserted the importance of continuance intention [5]. By involving this concept in investigating IS user behavior, it reveals the true factors of success that depends on continued use rather than first-time use. The model of IS continuance intention has been tested in different cases, such as the continued involvement of open-source software developers [32] and web-based learning systems [22]. Regarding task-technology fit, it was initially proposed by [14] that links information systems with individual performance. It has been tested in cases involving group support systems' effectiveness [34], the adaptation of wireless technology [29] and e-procurement systems [8].

Positive impacts of blended learning instruction on learning, where students have both face-to-face and virtual interaction with lecturers/classmates via an OLS, have been asserted [15]. Studies reveal the importance of investigating the role of TTF in motivating users to continue to use information systems [17] and the effects of TTF on learning [26]. However, there is not a complete understanding of the post-adoptive behavior of learners in terms of their intentions to continue to use an OLS and the link

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with learning impact on learning. This study integrates pre-acceptance variables, such as perceived fit and satisfaction, and the post-acceptance variable of OLS continuance intention to investigate OLS impacts on learning. Research questions addressed in this paper are as follows: (1) how do the pre-acceptance variables of perceived fit and satisfaction affect OLS continuance intention; and (2) how do the pre-acceptance variables and OLS continuance impact learning as perceived by students? This paper thus aims to shed light on the effect on learner performance of an IS, which in this case is the OLS.

The remainder of the paper is organized as follows: The next section documents the theoretical background and presents the research model. The third section describes the research methodology, applying the PLS method to empirically test the proposed model. The fourth section presents the results of data analysis. The last section discusses research implications for the key findings.

2 Theoretical Background and Hypotheses

Figure 1 depicts the research model proposed in this study. Based on the IS continuance model [4] and TTF [14], previous studies have made efforts to investigate factors motivating users to adopt ISs and factors influencing users to continue using them, as well as the link between IS usage and individual performance. The importance of OLS satisfaction for continuing web-based learning systems has been noted [23] [28].

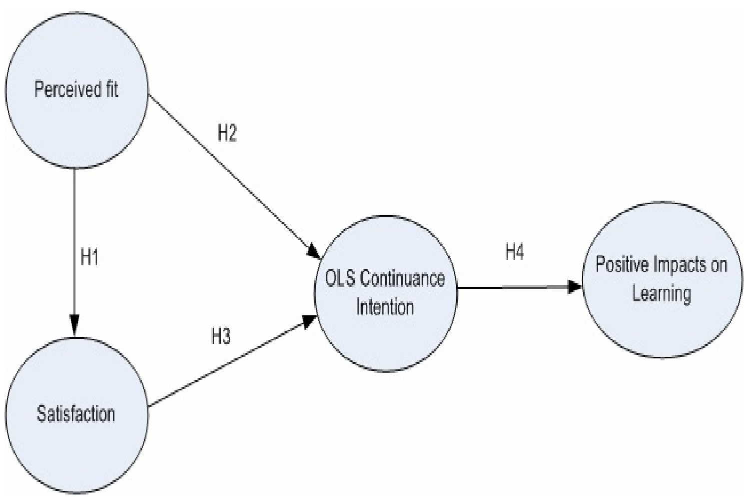

Fig. 1. The research model

Our study aims to empirically examine the link between perceived fit and satisfaction to OLS continuance intention. And the link between OLS continuance intention to perceived impacts on learning. As IS continuance intention orients the ideas proposed by self-confirmation [28] in the sense that students are offered the option to self-manage learning while assisted by an OLS, the link between OLS continuance intention and impacts on learning should be tested. In doing so, this will expand our understanding of IS continuance intention and its impact on individual performance.

In the followings, the research hypotheses are presented:

Researchers have empirically tested the positive relationship between perceived fit and utilization [14]. Utilization can be regarded as the behavioral intention to use [29] or as user adoption [33]. The link between perceived fit and OLS continuance intention is experimentally hypothesized. In our study, the construct is integrated to test the perceived value of satisfaction in terms of adopting OLS to fulfill the needs of gathering, constructing, or sharing knowledge. Therefore, we hypothesize the following:

H1 Perceived fit is positively related to satisfaction.

It is revealed that the perceived value of playfulness, the ease of use and the degree of usefulness are linked to task-technology fit [7]. In our study, this construct is integrated to test the perceived value of satisfaction in terms of adopting OLS for fulfilling the needs of gathering, constructing, or sharing knowledge. Therefore, we hypothesize the following:

H2 Perceived fit is positively related to OLS continuance intention.

Web-based learning continuance intention is investigated and revealed there is a link between system satisfaction [30] [27]. It asserts the relationship between satisfaction is linked with IS continuance intention. Therefore, we hypothesize the following:

H3 Satisfaction is positively related to OLS continuance intention.

The concept of IS continuance intentions has been empirically tested as the dependent variable in the case of online auctions [7], and eTax [16]. IS continuance behavior is defined as the continued sage of IS by adopters, where a continuance decision follows an initial acceptance decision [18]. In the case of online learning, the concept of OLS continuance intention also has been empirically examined [12]. Impacts on learners in blended learning instruction are discussed in the case of students [21] [25] and teacher learning [1]. Learner performance is evaluated using measurements of academic performance [6], learning effectiveness [15] and satisfaction [31]. [9] proposes that the use of a online learning system could positively affect perceived performance impacts. By combining theory on IS continuance intention and TTF, we hypothesize the following:

H4 OLS continuance intention is positively related to positive impacts on learning.

3 Research Methodology

A survey method was used to collect data, which were then used to test the research hypotheses.

3.1 Measurement Development

All of the items were measured on a five-point Likert scale ranging from strongly agree (5) to strongly disagree (1). The constructs were as follows:

a. *Perceived fit*. Measures the extent of perceived fit in terms of the usefulness of utilizing a OLS. It includes the ease of accomplishing assignments, making good use of the OLS and learning. Shortening of time spent for course preparation and impact on effectiveness in learning also are included. Similar scales for this construct have been used in previous studies [26] [27].

b. *Satisfaction*. Measures the extent of learners' satisfaction with a OLS in terms of conducting knowledge management relevant to learning via the OLS. It includes user satisfaction with utilizing OLS as a learning tool for knowledge management and specifically for gathering, sharing, analyzing, and constructing knowledge. The scale used for this construct was adopted from McGill and Hobbs [26].
c. *OLS continuance intention*. Measures the degree of learners' intention to continue using the OLS to conduct knowledge management in the class. It includes the intention to continue to use it to gather, construct and share knowledge. Additionally, the willingness to use the OLS to prepare the course works and the perceived suitability of the OLS are included. The scale adopted followed that of Vatanasombut *et al.*, used in the case of online banking, and that of Chan, used in the case of e-service tools [12].
d. *Impacts on learning*. Measures learners' perceptions of the impact of the OLS on their learning [21] [1]. The scale was adopted from McGill and Klobas [26] in the case of web-based learning systems. The degree to which learners perceived there to be learning includes the perceived effectiveness, productivity, importance, and helpfulness of the web-based learning systems for learning. This also showed better learning performance in terms of gaining a clear understanding and achieving the asserted learning goals.

3.2 Survey Administration and Participants

This study collected and analyzed perceptions of students who had taken part in a course that applied an online learning environment to assist in teaching and learning in class. The course, Introduction of Computer Science, which lasts for eighteen weeks, was selected. The participants of this study were students at a major university in the south of Taiwan who has took part in the course. Subjects use the web-based learning platform to gather teaching materials, share comments with classmates and exchange ideas about to assigned coursework. They mainly majors in management-related subjects, such as business administration and information systems.

4 Data Analysis

4.1 Demographic Information

The demographic information of subjects (n=165) are: a total of 44.8% (n=74) of respondents were male, and 55.2% (n=91) were female. A majority of respondents had one to two years (n=145, 87.9%) of experience utilizing OLSs and actively participated in the teaching and learning activities held via the OLS. They mostly majored in the subjects of the management of information systems (n=80, 48.5%) and Business Administration (n=75, 45.5%). Most respondents have previously submitted coursework online (n=163, 98.8%), joined a discussion board (n=141, 85.5%) and checked feedback sent by lecturers (n=135, 85.8%). In terms of general perceptions regarding the use of OLS to enhance learning, the majority of subjects responded positively (n=151, 91.5%).

4.2 PLS Analysis

The measurement model was assessed in terms of item reliability, convergent validity and discriminant validity tests. Individual item reliability can be examined by observing the factor loading of each item. A high loading implies that the shared variance between the construct and its measurement is higher than the error variance. A factor loading higher than 0.7 can be viewed as highly reliable, and a factor loading less than 0.5 should be dropped.

In accordance with the above, a number of variables were dropped because the factor loadings were less than 0.5. After the amendments, all constructs in the model satisfied the requirements for reliability (composite reliability greater than 0.70) and discriminant validity (average variance extracted was greater than 0.50, and the square root of AVE was greater than each correlation coefficient) (Table 1). Additionally, the discriminant and convergent validity are examined for each indicator [11].

Table 1. Reliabilities and discriminate validity

Model and construct	Mean	S.D.	Cronbach's alpha	Composite reliability	AVE	Correlation of constructs			
						CI	SA	PIL	PF
CI	3.49	0.71	0.89	0.92	0.64	**0.80**			
SA	3.23	0.80	0.90	0.92	0.66	0.62	**0.81**		
PIL	3.45	0.73	0.83	0.89	0.67	0.65	0.56	**0.82**	
PF	3.38	0.72	0.88	0.91	0.67	0.74	0.60	0.72	**0.82**

4.2.2 Structural Model

Table 2 documents the results of the path analysis. By applying the bootstrapping technique, the path estimates and t-statistics were calculated for the hypothesized relationships. Additionally, to evaluate the structural models' predictive power, the R^2 values for predicting constructs of perceived usefulness, the intention to continue OLS and positive impacts on learning were obtained. The R^2 value indicates the amount of variance explained by the exogenous variable [3]. The results indicate that all constructs had a positive and significant effect, which is consistent with the research hypotheses.

The results of H1 and H2 reveal that perceived fit is related to satisfaction (path coefficient = 0.597, t=8.950, p<0.000) and OLS continuance intention (path coefficient = 0.572, t=9.244, p<0.000). A test of H3 reveals that satisfaction is related to OLS continuance intention (path coefficient = 0.283, t=10.396, p<0.000). A test of H4 proves that OLS continuance intention is related to positive impacts perceived by learners (path coefficient = 0.654, t=11.015, p<0.000). The structural model predicted 43% of the variance.

Table 2. Path analysis-hypotheses testing results

	Path Coefficient	t-value
H1: PF→SAT	0.597	8.950***
H2: PF→CI	0.572	9.244***
H3: SAT→CI	0.283	10.396***
H4: CI→PIL	0.654	11.015***
	R^2= 43%	
***: p<0.000		

5 Discussions and Conclusions

In this study, we empirically examine current theories within the subject of technology continuance intention by combining the concept of perceived fit and experimentally testing the role between OLS continuance intention and the perceived impacts of an OLS on learning. The extension of IS continuance intention theory advances our understanding of how to keep students utilizing virtual learning systems. Perceived fit (β=0.572, p<0.000) and satisfaction (β=0.283, p<0.000) are positively related to OLS continuance, whereas perceived fit is related to perceived satisfaction (β=0.597, p<0.000). Therefore, the education institution should continue to update and create usefulness functions made available by an OLS, and instructors should promote the idea of self-learning to motivate students to actively adopt an OLS or have students continue to use it.

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References

1. Akyol, Z., Garrison, D.R.: Understanding cognitive presence in an online and blended community of inquiry: Assessing outcomes and processes for deep approaches to learning. Br. J. Educ. Tech. 42(2), 233–250 (2010)
2. Anderson, J.C., Gerbing, D.W.: Structural equation modeling in practice: A review and recommended two-step approach. Psychological Bull. 103(3), 411–423 (1988)
3. Barclay, D., Higgins, C., Thompson, R.: The Partial Least Squares (PLS) Approach to Causal Modeling: Personal Computer Adoption and Use as an Illustration. Tech. Stud. 2(2), 285–324 (1995)
4. Bhattacherjee, A.: Understanding information system continuance: An expectation-confirmation model. MIS Q. 25(3), 351–370 (2001)
5. Bhattacherjee, A., Perols, J., Sanford, C.: Information technology continuance: A theoretic extension and empirical test. J. Comput. Inform. Syst. 49(1), 267–293 (2008)
6. Bliuc, A., Ellis, R., Goodyear, P., Piggott, L.: Learning through face-to-face and online discussions: Associations between students' conceptions, approaches and academic performance in political science. Brit. J. Educ.al Tech. 41(3), 512–524 (2010)
7. Chang, H.H.: Task-Tech. fit and user acceptance of online auction. Int. J. Hum.-Comput. Stud. 68(1-2), 69–89 (2010)

8. Chang, H.L., Wang, K., Chiu, I.: Business-IT fit in e-procurement system: Evidence from high-technology firms in China. Inform. Syst. J. 18(4), 381–404 (2008)
9. Cheng, Y.M.: Antecedents and consequences of e-learning acceptance. Inform. Syst. J. 21(3), 269–299 (2010)
10. Cheung, M.Y., Luo, C., Sia, C.L., Chen, H.: Credibility of Electronic Word-of-Mouth: Informal and Normative Determinants of On-line Consumer Recommendations. Int. J. of Electron. Commerce 13(4), 9–38 (2009)
11. Chin, W.W., Marcolin, B.L., Newsted, P.R.: A partial least squares latent variable modeling approach for measuring interaction effects: Results form a Monte Carlo simulation study and electronic-mail emotion/adoption study. Inform. Syst. Res. 14(2), 189–217 (2003)
12. Chiu, C.M., Wang, E.T.G.: Understanding web-based learning continuance intention: The role of subjective task value. Inform. Manage. 45(3), 194–201 (2008)
13. Eijl, P.V., Pilot, A., Voogd, P.: Effects of collaborative and individual learning in a blended learning environment. Educ. Inform. Technolog. 10(1/2), 49–63 (2005)
14. Goodhue, D., Thompson, R.L.: Task-Tech. fit and individual performance. MIS Q. 19(2), 213–236 (1995)
15. Hui, W., Hu, P.J., Clark, T.H.K., Tam, K.Y., Milton, J.: Technology-assisted learning: a longitudinal field study of knowledge category, learning effectiveness and satisfaction in language learning. J. of Comput. Assisted Learn. 24(3), 245–259 (2008)
16. Hu, P., Brown, S.A., Thong, J., Chan, F., Tam, K.Y.: Determinants of services quality and continuance intention of online services: The case of eTax. J. of the AM. Soc. for Inform. Sci. Tech. 60(2), 292–306 (2009)
17. Larsen, T., Sørebø, A.M., Sørebø, Ø.: The role of task-technology fit as users' motivation to continue information system use. Comput. Hum. Behav. 25(3), 778–784 (2009)
18. Limayem, M., Hirt, G., Cheung, C.M.K.: How habit limits the predictive power of intention: The case of information systems continuance. MIS Q. 31(4), 705–737 (2007)
19. Karahanna, E., Agarwal, R., Angst, C.M.: Reconceptualizing compatibility beliefs in technology acceptance research. MIS Q. 30(4), 781–804 (2006)
20. Komiak, S.Y.X., Benbasat, I.: The effects of personalization and familiarity on trust in and adoption of recommendation agents. Manage. Inform. Syst. Q. 30(4), 941–960 (2006)
21. Lim, D.H., Morris, M.L.: Learner and instructional factors influencing learning outcomes within a blended learning environment. Educ.al Tech. & Soc. 12(4), 282–293 (2009)
22. Liao, C., Palvia, P., Chen, J.L.: Information Technology adoption behavior life cycle: Toward a technology continuance theory. Int. J. of Inform. Manage. 29(4), 309–320 (2009)
23. Limayem, M., Cheung, C.: Understanding information systems continuance: The case of Internet-based learning technologies. Inform. Manage. 45(4), 227–232 (2008)
24. Lin, K.M.: E-learning continuance intention: Moderating effect of user e-learning experience. Comput. & Educ. 56(2), 515–526 (2011)
25. Lu, J., Yu, C.S., Liu, C.: Learning style, learning patterns, and learning performance in a WebCT-based MIS course. Inform. Manage. 40(6), 497–507 (2003)
26. McGill, T.J., Hobbs, V.J.: How students and instructors using a virtual learning environment perceive the fit between technology and task. J. Comput. Assisted Learn. 24(3), 191–202 (2008)
27. Roca, J.C., Gagné, M.: Understanding e-learning continuance intention in the workplace: A self-determination theory perspective. Comput. Hum. Behav. 24(4), 1585–1604 (2008)
28. Sørebø, Ø., Halvari, H., Gulli, V.F., Kristiansen, R.: The role of self-determination theory in explaining teacher's motivation to continue to use e-learning technology. Comput. Educ. 53(4), 1177–1187 (2009)

29. Yen, D., Wu, C.S., Cheng, F.F., Huang, Y.W.: Determinants of users' intention to adopt wireless Tech.: An empirical study by integrating TTF with TAM. Comput. Hum. Behav. 26(5), 906–915 (2010)
30. Yeung, P., Jordan, E.: The continued usage of business e-learning course in Hong Kong corporations. Educ. Inform. Tech. 12(3), 175–188 (2007)
31. Wan, Z., Wang, Y., Haggerty, N.: Why people benefit from e-learning differently: The effects of psychological processes on e-learning outcomes. Inform. Manage. 45(8), 513–521 (2008)
32. Wu, C.G., Gerlach, J.H., Young, C.E.: An empirical analysis of open source software developers' motivations and continuance intentions. Inform. Manage. 44(3), 253–262 (2007)
33. Zhou, T., Lu, Y., Wang, B.: Integrating TTF and UTAUT to explain mobile banking user adoption. Comput. Hum. Behav. 26(4), 760–767 (2010)
34. Zigurs, I., Buckland, B.K.: A theory of task-technology fit and group support systems effectiveness. MIS Q. 22(3), 313–334 (1998)

The Relationship of Motives and Achievements in Teacher's Online Training Course

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Abstract. The purpose of this study is to examine the correlations between motivation and achievement of online training course of middle and elementary school teachers, as well as the impact of variables on overall learning achievement. The outcomes indicate teachers are highly motivated to participate in online training course. Typical correlation test shows motives and learning achievements supplement and affect each other.

Keywords: Online training course, motivation, learning achievement.

1 Introduction

Based on the global information network as the platform, distance learning incorporates words, images and multimedia information. Taking advantage of the independence of hyperlink, it breaks through time/space limitation of conventional "teaching" and "learning" and present diversified learning information. In response to students' individuality, it attempts to realize the idea of "instruction accordance with individual aptitudes" [1]. Maturing distance learning concepts bring about many new education ideas and values. It has become a trend to utilize network technology to help middle and elementary school teachers with on-job training [2].

The purpose of this study is to examine the correlations between the motives and achievements of online on-job training of middle and elementary school teachers in an asynchronous environment. Main objectives include: Exploration of different motives and achievements of online on-job training of middle and elementary school teachers, correlations between the motives and achievements, and the impact of variables on overall learning achievement.

2 Literature Review

The characteristic of distance learning is that teachers through technology-based systematic materials help students who are in different places learn. The learning, therefore, is individualized [3]. The fact that teachers and students are separated in distance

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learning requires students' self-motivated participation, self-guided learning activity and individualized learning pace in order to construct a personal knowledge system [4],[5]. In this sense, distance learning differs from conventional classroom instructions in four aspects: breakthrough of time/space barriers, media-based instruction, learner-based learning style, and systematic yet flexible teaching materials [6].

Motivation comes from the Latin word *mocere*, which means "to move" [7]. Teachers normally are motivated to engage in on-job training because of governing agency's administrative measures and related environmental factors, such as listing on-job training as basis for promotion or raise or listing it as a performance evaluation requirement. Internally stimulated motives have to do with teachers' professional attitude and values. Whether a teacher is willing to participate in on-job training is directly associated with his professional inclination, service attitude, value judgment and sense of achievement [8].

N.H. Chen [9] believes: Establishment of e-learning systems should take into account environmental components that affect learning achievement: (1) Teacher side－Teaching interaction, process control and post-class follow-up; (2) Student side－Peer interaction, learning independence, participation motive; (3) Teaching material side－Resource diversity, presentation richness, material appropriateness; (4)Classroom side－Space convenience, equipment entirety.

Y. J. Chen [10] is of the opinion that: Learners will be more diligent when they are interested in or feel the threat of a new teaching approach. The former is the novelty effect; the latter is John Henry effect. Both are responsive effects that temporarily enhance students' learning achievement and make one miss the real effect of distance education.

The teaching aspect includes teaching interactions, learners' independence and aggressiveness in study planning and reflection, teachers' teaching dedication and ability to use media, learners' satisfaction with the teaching, learners' learning achievement, continuation and completion rate of teaching approaches, and learners' turnover and growth rate.

The technology aspect refers to the extent of technology in the content of distance education, network connection speed, visual/audio signal quality, ability to arrange technological equipments, and ability to integrate different information.

The organizational aspect refers to software/hardware maintenance and management, course arrangement, organization-given resources, teachers and staffs' training, inter-school cooperation and school-industry cooperation.

The moral aspect focuses on learners' participation opportunities and association with student levels, academic goals and strategies of schools, quality of Internet information obtained, learners' ability to judge and apply information, and whether teaching materials infringe on other's intellectual property rights.

3 Research Method and Tool

Research participants are teachers who took part in Network Technology and Management, Multimedia and Program Design graduate credit point classes of National Taipei Normal College's asynchronous distance education program.

Internet questionnaire surveys are conducted during pre-term, mid-term and end-of-term times of each course. Questionnaire contents are divided into: "Basic Data and Past Information Training," "Questionnaire on Motives behind Teachers' Participation in Online On-Job Training" and "Questionnaire on Achievement of Teachers' Participation in Online On-Job Training."

The questionnaire survey includes three parts: background variables, independent variables and dependent variables. Background variables include: gender, age, highest education, job position, seniority, past information training, regular school, information seed school and other school. Independent variables include: interest in knowledge, pursuit of achievement, social participation/other's influence, Evasion/stimulation and professional development. Dependent variables include learning satisfaction and on-job training/on-job application achievement.

This study compiles "Survey Questionnaire on Online On-Job Training of Middle and Elementary School Teachers," including three parts: The first part is "Basic Data and Past Information Training." The second part is "Questionnaire on Motives behind Teachers' Participation in Online On-Job Training." The third part is "Questionnaire on Achievement of Teachers' Participation in Online On-Job Training."

4 Research Outcomes

This study employs Likert Scale to measure degree of importance – 5 being the highest score and 3 being the medium. Analysis shows that average scores of "Interest in Knowledge" and "Professional Development," indicating teachers are more aggressive in these two areas and less aggressive in "Pursuit of Achievement," "Social Participation/Other's Influence" and "Evasion/Stimulation." The average scores of all the questions fall between 2.88~4.45, indicating at present teachers are highly motivated to participate in online on-job training. Outcomes are shown in Table 1.

The average score of "Learning Satisfaction" is higher. The average score of "On-Job Training/ On-Job Application Achievement" is not enough. The average scores of all the questions fall between 3.78~4.24, indicating at present teachers' achievement of online on-job training is very high. Statistical outcomes are shown in Table 2.

Typical Correlation between Online Training Motives and Achievements Concerning the correlation between the five online on-jobs training motive categories and the two achievement categories, when p reaches 0.5, two sets of typical correlation coefficients reach the significant level. There is significant correlation between χ_1 and η_1, between χ_2 and η_2. Both the two typical significance tests reach the significance level of over .05. The first typical characteristic value is .773 ($p<.05$); the second typical characteristic value is .235 ($p<.05$). The five control variables mainly through the two typical factors affect the effect variable (dependent variable). Outline of the analysis is shown in Table 3.

Table 1. Analysis of Motives of Teachers' Participation in Online On-Job Training

Items	Average	Standard Deviation
I. Interest in Knowledge	4.37	2.51
II. Pursuit of Achievement	3.50	2.02
III. Social Participation/Other's Influence	3.25	3.53
IV. Evasion/Stimulation	3.94	2.12
V. Professional Development	4.07	2.17

Table 2. Analysis of Achievement of Teachers' Participation in Online On-Job Training

Items	Average	Standard Deviation
I. Learning Satisfaction	4.09	2.15
II. On-Job Training/ On-Job Application Achievement	3.93	2.40

Table 3. Typical Correlation between Online On-Job Training Motives and Achievements

Control Variable (ariable X)	Typical Factor		Effect Variable (Variable Y)	Typical Factor	
	χ_1	χ_2		η_1	η_2
Interest in Knowledge	.423	.250	Learning Satisfaction	1.000	-.008
Social Participation/ Other's Influence	-.207	-.723	On-Job Training/ On-Job Application Achievement	-.102	-.995
Professional Development	.520	-.093			
Evasion/ Stimulation	.623	.428			
Pursuit of Achievement	.623	.419			
Percentage of Extracted Variable	19.159	19.059		50.514	49.49
Overlapping	8.352	3.628		22.020	9.41
			ρ2	.436	0.190
			Typical Correlation (ρ)	.660*	.436*

5 Conclusions

The purpose of this study is to examine the correlations between motivation and achievement of online training course of middle and elementary school teachers, as well as the impact of variables on overall learning achievement.

Correlation coefficients of .27, .34 and .41 are noted between motive categories ("Interest in Knowledge," "Professional Development" and "Evasion/Stimulation") and learning achievement category "Learning Satisfaction," indicating in product-moment correlation test teachers' online on-job training motives are closely associated with learning satisfaction. Analysis of correlation between teachers' online on-job training motives and "On-Job Training/ On-Job Application Achievement" shows the two are significantly correlated.

Analysis of typical correlation between online on-job training motives and achievements under the condition that p reaches .05 shows two sets of typical correlation factors reach significant levels, indicating the two are closely associated – the stronger the learning motive, the higher the learning achievement will be.

References

1. Li, S.-Y.: Survey and Analysis of Teachers' Need to Study Math Teaching through the Internet. Study and Development of Science Education, 2003 Special Issue, 120–147 (2003)
2. Chiu, C.-H., Wu, H.-M.: On Teacher's Distance On-Job Training. Information and Education (76), 41–46 (2000)
3. Lin, M.-H.: South Africa University's Distance Education. Adult Education (18), 14–18 (1994)
4. Keegan, D.: The foundations of distance education. Croom Helm, London (1996)
5. Huang, J.-S., Huang, M.-Y.: Definition, Development and Theoretic Foundation of Distance Education. National Taichung Normal College Journal (13), 497–508 (1999)
6. Li, T.-W., You, G.-J., Dai, J.-Y.: Evaluation of Preliminary System of Distance Education, pp. 114–120. Ministry of Education Technology Advisor's Office, Taipei (1996)
7. Wang, J.-H.: Motives of Elementary School Teachers' Participation in On-Job Training and Their Openness to Innovations, master thesis of National Chiayi University Graduate School of Education (2000)
8. Gsttidon, D.R., Shale, D.: Mapping the boundaries of distance education: Problems in defining the field. The American Journal of Distance Education 1(1), 7–13 (1987)
9. Chen, N.H., Wang, M.H.: Tools for Web Courseware Production. In: Eighth International Information Management Forum Symposium, pp. 667–674 (1997)
10. Chen, Y.-J.: Disputes over Distance Learning Achievement and Evaluation Mechanism for Distance Education System. Teaching Technology and Media (56), 40–49 (2001)

Students Practice Minimally Invasive Surgery through Game-Based Assisted Learning

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Abstract. Minimally invasive surgery (MIS) is revolutionary skill of surgical operation for a surgeon. Minimally invasive surgery which is specialized operationuses miniature cameras with microscopes, tiny fiber-optic flashlights and high definition monitors through small incisions.Patients leave the hospital sooner after minimally invasive surgery because MIS make patients less trauma to their bodies. However, it is difficult for surgeons to learn the skill especially in first-year resident surgeons. Moreover, they have to practice the high-level skill in animals. The action which costs lots of cash for hospitalis cruel to animals.In order to reduce casualty and save money, this study uses game-based learning to help resident surgeonsto learn the procedure of MIS.

Keyword: Minimally Invasive Surgery, Game-Based Learning, E-Learning.

1 Research Background and Motivation

In an era of Hi-technology, combining new skill and technology in medical field are constant. Minimally invasive surgery (MIS) is getting more and more important for a surgeon to operate a better operation on patient. Surgeon cut small incisions on human surface to insert laparoscope and camera with microscopes to operate a surgery. Therefore, it takes a shorter time for patient to recover from the minimally invasive surgery than traditional surgery.

The way of learning by computer assisted has become an important characteristic on medical education recently. Digital content and technology, auxiliary tools, and the curriculum have been played key role onmedical education. Moreover, surgeon always use animal to practice their skill or train surgeon of next generation. It costs a lot of money and cruel. Therefore, computer assisted learning on medical educationmay become amethod to help surgeonto learn new skill of surgery and save a big money. However, how do we make good use of the medical field in this technology? And is the environment of computer assisted learning on medical education really helpful to the learning performance? These issues as above are important which we should consider in the meanwhile when developing digital content.

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2 Literature Review

Constructivism is a learning theory. Its knowledge perspective is that knowledge is not the absolute truth. It is the assimilation and adjustment of learning activities. It can't be transferred because of variation. In traditional epistemology, knowledge is the reflection of objective real world. These two ideas are totally different. Epistemology of construction emphasizes the human-based idea. Knowledge is actively constructed by learners. In the learning process, knowledge can be practical by interaction between perceiver and cognitive subject, but not to be received passively.

People of constructivism consider the learning behavior of human is a process of active construction. It means that students learn things actively, explore knowledge by themselves, internalize it and establish their own understanding and meaning. The example as above shows that learning is the construction process to continuously accommodate, adjust, and recombine the knowledge structure. In order to construct knowledge, students have to confirm their previous knowledge, explain the experience in their learning activities, define proposition to be meaningful, and base on this to adjust their cognitive structure. And instructors should provide things which will cause students' cognitive disorientate and curiosity of solving questions, it can encourage students to construct knowledge[3]. Fosnot (1989) also regard that knowledge is the experience of constructing oneself in this objective world[2]. It is a kind of experience to explain oneself by a logical structure assimilating, organizing and adjusting. Woolfolk proposes that students actively construct their own knowledge by the information import from the outside world. Students have cognitive adjustment in their mind and make it become the real knowledge [4].

Game-based learning (GBL) is that use games for learning or educational purposes, moreover, GBL areeducational gamesas applications that have improvedlearner's learning outcomes[1]. Most learners like playing games, therefore the most effective way to use game-based learning is to make learners to enjoy learning with playing games. Game-based learning also motivate learner to learn through feedback responses. Motivation is a key point that learner can learn well. Therefore, the study decide to create a game-based learning system to help surgeons to learn minimally invasive surgery.

3 Methodology

The researchers design a game-based learning system to help resident surgeons. Seven the first year resident surgeons participate this study. After participants practice the system about one hour, researchers interview them immediately. Their feedback is described in discussion. The process of game-based learning system is showed as pictures below step by step. Fig1 shows the main page of this system.

Fig 2 is a welcome page. After learner clicks the "start operation" button, the systemscreen comes to welcome page. Learners have three options. Introducing the surgery's tools when learners pressing the top button. When learners press the middle button, the system introduces the step of operation. If learners don't need any help, they can entry to practice a real operation.

Fig. 1. The main page of the system

Fig. 2. Welcome page

Fig 3 is an introduction page of all operational tools. Fig4 and Fig5 are example of operational tools. When learner press the tools icon, the system shows the enlarge picture and detail explanation of the selected tool.

In fig 6, learners can practice to connect picture of tools and name of tools to check if they understand all of them.

Fig 7 is the step of operation. In welcome page, after learners press the middle of button, the system screen shows the whole process of operation with explanation.

Fig 8 shows the start page of operation. In welcome page, if learners choose the third button (the bottom of button), the system screen entry the main function of the system which start operation in real situation.

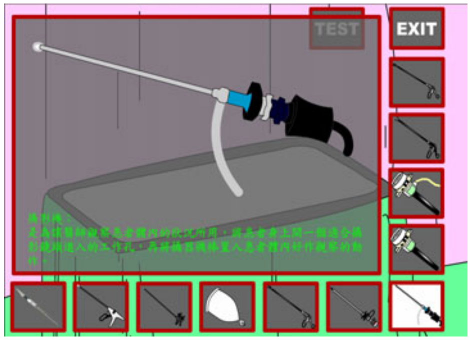

Fig. 3. Introduction of operational tools

Fig. 4. Grasp

Fig. 5. Knife

Fig. 6. Exam of surgery tools

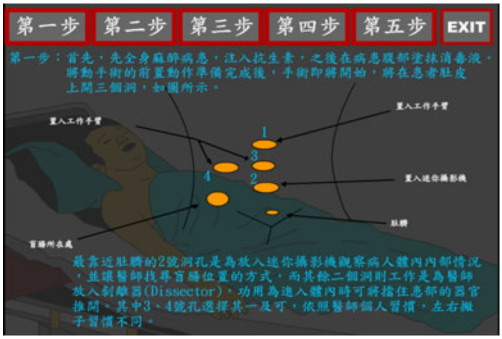

Fig. 7. The process of operation

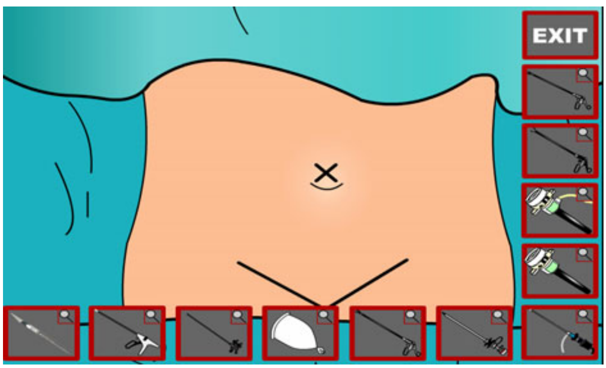

Fig. 8. Start operation

In Fig 9, in order to start operation, learners have to choose the correct tools to continue the surgery.

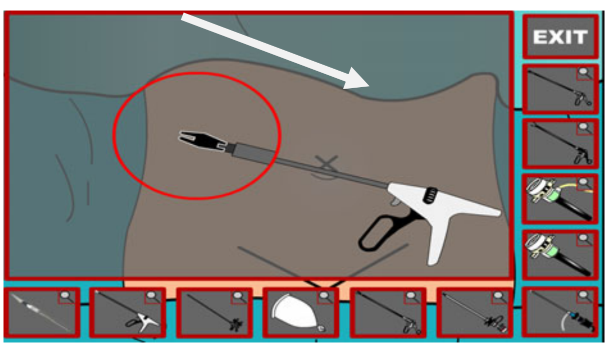

Fig. 9. Choose the correct tools to operatethe surgery

In Fig 10, learners have to choose correct tools and click the correct stepsin order to complete the surgery. Otherwise, the surgery is fail and goes back to main page.

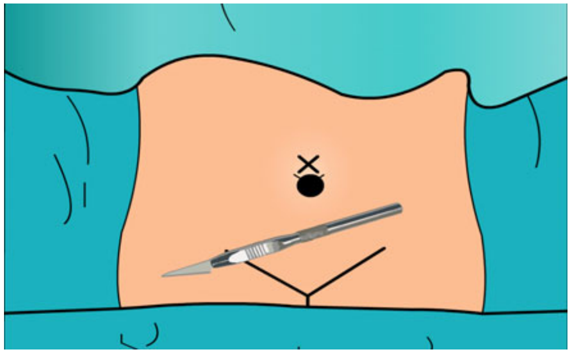

Fig. 10. Choosing correct tools and step can complete the surgery

4 Result and Discussion

All participants satisfied and learned a lot from this game-based learning system. One of participants said *"It was really exciting to use such wonderful software, providing great opportunity to the surgeon to learn skills of minimally invasive surgery through the system. It was good to learn from playing a game and custom software developed by easy way to learn. I learn faster through computer games."* Another participant said "*The surgery is difficult to learn quickly because it need time to practice it, especially for minimally invasive surgery. I can't image that researchers can create such useful software to train young surgeon to know the process of minimally invasive surgery. MIS is a brand new skill of operation. A few surgeon can do surgery using MIS. This software is so helpful and I learn a lot from it.*" The software is successful example of game-based learning.

References

1. de Freitas, S., Savill-Smith, C., Attewell, J.: Educational games and simulations: Case Studies from Adult Learning Practice. Learning and Skills Research Centre, London (2006)
2. Fosnot, C.T.: Enquiring Teachers, Enquiring Learners: A Constructivist. Approach to Teaching. Teachers College Press, New York (1989)
3. Vosniadou, S., Brewer, W.F.: Theories of knowledge restructuring in development. Review of Educational Research, 51 (1987)
4. Woolfolk, A.E.: Educational Psychology. Allyn and Bacon, Needham Heights (1993)

The Study of Developing Spatial Ability by Applying Game-Based Learning

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Abstract. Spatial ability is an important living ability. As an individual lives in the environment, he or she will overturn or rotate objects and identify directions; this is one type of spatial ability. In addition, identifying the differences of certain spatial abilities such as spatial orientation, spatial visualization or spatial reasoning is the performance of spatial ability. Whether computer games can assist the development of spatial ability or not is the focus that scholar discussed. In summary, this study tried to develop a cubic enumeration testing system by game-based learning theory and Item Response Theory (IRT) and used this challenging game to investigate its effect on students' development of spatial ability. The following are the research questions in this study: Can the game of spatial ability develop spatial ability? Are there difference between the developments of spatial ability assisted by different games.

Keywords: Spatial ability, Game-based learning, Item Response Theory, IRT.

1 Introduction

Playing games is an ancient behavior and a human instinct. The development of information technology industry has transformed actual games to computer games. Students also have more opportunities to play computer games. In the light of this, the application of computer games in education also is widely discussed and researched. Some researchers regarded that the introduction of computer games into students' learning activity will significantly enhance their learning motivation and knowledge.However, students should not only focus the intelligence on learning ability related to school work (Gardner,1983), we should value their development of multiple kinds of ability. The intelligence that is valued increasingly is "spatial intelligence", also called "spatial ability." The theory of multiple intelligences proposed by Gardner made us value not only learning ability but also multiple intelligences in teaching.

Spatial ability is an important living ability. As an individual lives in the environment, he or she will overturn or rotate objects and identify directions; this is one type of spatial ability. In addition, identifying the differences of certain spatial abilities such as spatial orientation, spatial visualization or spatial reasoning is the performance of spatial ability. Whether computer games can assist the development of spatial ability or not is the focus that scholar discussed. In summary, this study

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tried to develop a game-based cubic enumeration testing system and used this challenging game to investigate its effect on students' development of spatial ability. The following are the research questions in this study:

1. Can the game of spatial ability develop spatial ability?
2. The comparison between the developments of spatial ability assisted by different games.

2 Literature Review

2.1 Game-Based Learning

Game-based learning refers to learning by playing games, and learners will have the sense of achievement by solving problems and overcoming challenges in games. Game-based learning combines recreation and education and its purpose is to educate in the form of recreation. There are plenty of games based on spatial ability; for example, Lego, Tangram, Pentomino…etc. are famous games of spatial ability. Tetric (tetrominoes) is a member of pentomino family. 30 years ago Russian scientists used tetrominoes to train students' spatial ability. In this game, the most frequently used operations of "figure rotation" and "figure combination" are the basic and significant mental abilities and the important elements of spatial reasoning. This game is usually used as the tests for nonverbal intelligences by psychologists. Lego is a quite popular educational toy and is valued by numerous parents and teachers. Tangram is a lasting Chinese toy, and overseas scholars studied it and their results showed that using tangram could enhance students' mathematics geometry abilities (Smith & Olkun, 2005).

The characteristics of game-based learning are the following: Recreation: Games are in the form of fun and can make learners feel interested and pleasant during the process of playing games. Play: It provides a form of play and offers learners high motivation to play games and intense pleasure. Rule: The contents of games are structural, and this makes learners easily organize the contents, play games and interact with them. Goal: The tangible goals and tasks in games clearly guide learners to play games. Human-Computer Interaction: The interface is game-based, and learners operate on and interact with computers to play games. Result and Feedback: Games provide learners opportunities to learn. Adaptability: Games can be designed to assign appropriate tasks according to learners' ability levels. They are adaptive. The Sense of Victory: In playing games, learners obtain experiences of victory which will give them the sense of self-satisfaction. Conflict, Competition and Challenge: Conflict, competition and conflict in games make learners adrenalinize. Problem Solving: In games, there are problems to stimulate learners' creativity. Social Interaction: Games allow learners to form game community and bring about interaction. Image and Plot: Images and plots of games allow learners to acquire affection (Prensky, 2007).

In addition, game-based learning also can: Stimulate inner motivation and enhance interest: The characteristics of curiosity, expectation, control, interactivity, and fantasy of stories of games can enhance learners' learning interest and inner motivation. Learners will keep on trying when they face challenges in order to obtain the sense of achievement. Retain memory: Compared to traditional courses, simulated games have better effects to retain the memory. Provide practice and feedback: Many game-based software provide learners with chances to practice and they can operate repeatedly and obtain instant feedback, and they can evaluate learning results by themselves and accomplish learning goals. Provide high-level thought: The designs of computer games conform to human's perception structure. Integrating teaching contents into games allows learners solve problems and make decisions constantly, and learners have to find out solutions by integrating what they have learned. Teaching contents will be put into their memory constantly, and this is the best learning form (Hogle,1996).

2.2 Spatial Ability

McGee divided spatial ability into two elements - "Spatial Visualization" and "Spatial Orientation" - in his study in 1979. "Spatial Visualization" referred to one's ability to perform the perception process such as figure operation, rotation and overturn in his or her mind when facing figures; "Spatial Orientation" referred to one's ability to be clear about objects or figures which constantly change directions. Linn and Petersen (1985) divided spatial ability into the following 3 elements "Spatial Perception", "Mental Rotation" and "Spatial Visualization". "Spatial Perception" meant one's ability to identify spatial relationship; "Mental Rotation" meant one's ability to imagine figures when they are rotated; "Spatial Visualization" meant one's ability to perform folding and moving of a series of complicated images. The difference of McGee between Linn and Petersen is that the latter drew "Mental Rotation" from "Spatial Visualization" and made it a factor of spatial ability.

In addition, scholar Lohman brought up that there were 3 main factors - "Spatial Relations", "Spatial Orientation" and "Visualization" in 1979. Among them, "Spatial Relations" referred to one's inner ability to process rotation of objects; although it had the element of mental rotation, this ability mainly meant the ability to solve spatial problems swiftly by any means rather than the speed of mental rotation. In other words, when one faces spatial problems and one can solve spatial problems swiftly by various means including mental rotation, and this was called "spatial relations". It did not refer to the speed to imagine the rotation of figures or objects in one's mind. "Spatial Orientation" referred to one's ability to perform imagination to observe objects by different angles, and "Visualization" referred to one's ability to imagine 2D figures into 3D objects. Lohman did not use the term "mental rotation"; however, the definition of "Spatial Relations" was similar to the definition of "mental rotation" of Linn and Petersen.

2.3 Cube Enumeration

Some researchers applied cuboids to explore how individual constructed 3D mental objects with 2D figures (Olkun & Knaupp, 2010). T hese researchers believed that the wrong responses to cube enumeration test item are due to the failed transformation of mental images from 2D figures to 3D mental objects and the lack of perspective to count the hidden cubes. Cube enumeration tasks for IQ test (Chiang, 1984) and mathematics programs are more than regular cuboids and many of the tasks are irregular cuboids. The educational tasks of Battista (1999) and Olkun and Knaupp (2010) are essentially helpful for most students to develop their spatial orientation (spatial structuring), the ability to distinguish between cubes and 2D squares, to build mental 3D objects from 2D figures and to identify the relative location of each cubes. The reference of this study is the above research, which is based on virtual exam system theory and combines IRT and CAT theories, to perform the automatic proposition of cube enumeration test and hope to solve the problem of examination question exposure and organization difficulty. In addition, plan to produce several tools, which will be helpful for examination question organizer or teacher in the use of examination and teaching.

3 Research

In order to understand the improvement of students' spatial ability assisted by the game of space and creativity, this study defined the research framework according to the purposes of this study as followed:

Subject: The subjects of this study were the students of 3 classes in the 4th grade of an elementary school. Among them, students of 2 classes were in the experimental group (Class A and B), and students of 1 class were in the control group (Class C).

Research Tool: In this study, we construct a cubic enumeration testing software as research tool. The accuracy and subjective difficulty of the question are used to reason and solve the cognitive process of cube enumeration operation. The subjective difficulty adopts the accuracy data of larger sample numbers in group testing collection. As for testing objects, three elementary schools in different counties and cities are selected, and 2 three-grade classes are selected in each school. The research material is cube enumeration examination question. The question manipulates two independent variables, one is the number of cubes, which includes 15, 16, 17, 18, 19, 20 and 21, and another is the number of invisible cubes, including 3, 4, 5, 6 and 7. The organization stage of cube enumeration test is demonstrated in the figure below:

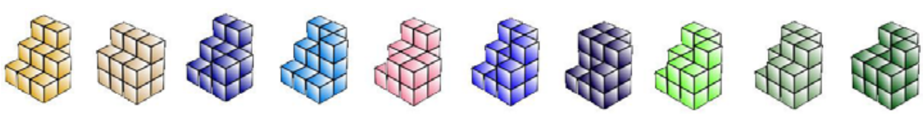

Fig. 1. The organization stage of cube enumeration test

In this study we divide into three stages to construct test, get IRT parameters and implement research tools. These three stages are as follow: Stage 1: Test Construction. Twenty-two items will be constructed as the pretest item bank according to our research hypothesis. Number of different types of items is summarized as the following Table. The items will be used in a pretest of 231 third-grade students in the elementary school for item selection for the formal test. Items will be selected by their respective item difficulty index (P), discrimination index (D) that is the product-moment correlation of the total score of 231 examinees. The item selection criteria for the present study are pretest difficulty index that is between 0.2

to 0.9, discrimination index which is above 0 and point-biserial correlation which is significant at the significance level of $\alpha=0.05$. Inappropriate items judged by their item difficulty index, discrimination index and point-biserial correlation will be excluded after pretest analyses and an item bank for the formal test of 20 items will be constructed are acceptable.

4 Results

Examinee's ability was estimated with a computer test taken by 50 examinees randomly selected from the pretest sample with the virtual item bank system developed by this research. To test the capability of the system to estimate examinee spatial ability, a dependent sample t-test was conducted to compare the ability estimation and the true spatial ability measured by the formal test of 20 items. The result is insignificant with t-value at 1.254 (p□ $0.21>0.05$). Therefore, we accept that there was no significant difference between the system-estimated ability and the true value of ability. As the result, the virtual item bank system developed by the present research is verified for its precise estimation of examinees' true ability. Descriptive statistics of the subjects.

References

1. Battista, M.T., Clements, D.H.: Student's Understanding of Three-Dimensional Rectangular Arrays of Cubes. Journal for Research in Mathematics Education 27(3), 258–292 (1996)
2. Chiang, C.T.: Visual-spatial dimensions of cognitive ability. National Changhua University of Education, Taipei (1984)
3. Gardner, H.: Frames of Mind: The theory of multiple intelligences. Basic Books, New York (1983)
4. Hogle, J.G.: Considering Games as Cognitive Tools: In Search of Effective Edutainment. University of Georgia Department of Instructional Technology (1996)
5. Linn, M.C., Petersen, A.C.: Emergence and characterization of gender differences in spatial ability: A meta-analysis. Child Development 56, 1479–1498 (1985)
6. Olkun, S., Knaupp, J.E.: Children's understanding of rectangular solids made of small cubes. LAP Lambert Academic Publishing, Germany (2010)
7. Prensky, M.: Digital Game-Based Learning. McGraw-Hill, New York (2007)

A Study of Cooperative and Collaborative Online Game-Based Learning Systems

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Abstract. The study employs the quasi-experiment method to evaluate teaching achievements. The learning achievements of the two online game-type computer assisted learning systems are significantly better than that of conventional approaches. Studies of the correlation of gender and cooperation patterns indicate it is more suitable for boys to participate in collaborative learning games while girls perform well in both teamwork learning patterns.

Keywords: Cooperative Learning, Collaborative Learning, Online Game-Styled Learning System.

1 Introduction

Many are under the impression that as long as the teacher divides the students into several groups, let them discuss together and present their conclusions later, it would be considered teamwork learning. This kind of grouping approach, however, can easily lead to nominal teamwork learning in which more capable students are given more responsibilities while less competent students are relegated to token roles [1]. As a result, more capable students will learn faster than less competent students, and as the vicious circle repeats itself high-achievers will be better and better and low-achievers will only be moving toward the opposite direction [2]. To rectify this problem, we plan to introduce effective responsibility sharing and cooperation to group studies in accordance with characteristics of different teamwork learning approaches in order to attain the goal of studies.

Based on the description above, the purposes of this study are:

1. The online game-style computer-assisted learning system that includes two learning models, Cooperative Learning and Collaborative Learning, is designed to engage students in four study units: volume, fraction, angle and length.
2. To explore which learning mode – Cooperative Learning or Collaborative Learning – is more helpful in assisting fourth graders with math studies.
3. To examine whether the cooperative online math game environment enhances students' willingness and ability to learn, in hopes that research outcomes can serve as reference for teachers in development of information-blended teaching approaches.

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2 Literature Review

The idea of teamwork learning is not new. Since the ancient past there have been scholars advocating the concept of teamwork learning. “Those who study alone without friends tend to be narrow-minded and uninformed,” said Confucius. “Where there are as few as three people, I can find someone to teach me something.” The great philosopher was referring to the fact that the power of self is weak and that the strength and wisdom of every member of the group is needed. Palincsar [3] indicates “teamwork learning” is about assigning students to small groups in which they learn through cooperation. Students work together to accomplish the objective. Through the information they discuss, interact with one another and encourage one another critiquing one another’s viewpoints for adjustment, so all the students of each group can learn the designated materials. Teamwork learning is the essential component of constructivism. It is a concept of teaching design that encourages students to continue to discuss with others and exchange opinions with others in the learning process in order to construct knowledge that is meaningful to the students [4].

Cooperative Learning: Cooperative learning is often applied to group learning. Through group discussions students solve the problems [5]. In group learning of uneven task distribution, responsibility sharing is often relegated to mere formality possibly because of the fact that high-achievers for fear of being slowed down by the low-achievers choose to attain the goal alone that is meant for group completion and thereby deprive teamwork learning of its meaning. Conversely, it is also possible that in order to evade heavy responsibility high-achievers may purposely hide their ability and shift the burden to others. To avoid this situation, we need to separate “team learning” from “cooperative learning.” “Cooperative learning” is meant for every student of the team to assume the responsibility of accomplishing a part of the learning objective. Every part is equally important. It requires all to pool their efforts together in order to accomplish the mission of the team. That is genuine cooperative learning [6]. Johnson & Johnson [7] believe cooperation is a relationship of reciprocal assistance that requires individual responsibilities. Every member of the group needs to learn and develop communication skills and makes decisions through communication and mutual trust.

Collaborative Learning: This is clearly a social process among group members who could adopt various strategies for resolving differences including asserting dominance, acquiescing, or some form of reciprocal sense making. An important aspect of collaborative learning is the move from assimilation to construction [8]. Collaborative learning in practice, therefore, is allowing a group of learners to explore learning problems through active interaction and remove these problems [9]. In this type of teamwork learning, there is no clear distinction between the role of a teacher and that of a student. The convention teaching approach is not followed. No longer is a knowledge provider, the teacher there to give students guidance. No specific responsibility-sharing structure is prescribed. Through interactive discussions, all learners work together to establish consensus on learning objectives and solve common problems. The classroom is not the only place where collaborative learning takes place. The practice can be expanded to the entire society. Any place that allows learners to discuss and work with one another is appropriate for collaborative learning. In essence, collaborative learning researchers tend to employ the method of constructivism. So collaborative learning is basically in line with the approach of the "constructive teaching method" [2].

3 Research Design and Method

This study evaluates teaching achievement mainly through the quasi-experiment method. Before the experiment, both the experiment group and the control group received the pretest on "the four math units of the Fall Semester of the Fourth Grade." The four-week experimental teaching followed. After the experiment concluded, they received the posttest on "the four math units of the Fall Semester of the Fourth Grade." The design of the experiment is shown in Table 1:

Table 1. Brief Table of Experiment Design

Teams	Pre-test	Handling of Experiment	Post-test
First Experiment Team	X	X1	X2
Second Experiment Team	Y	Y1	Y2
Control Team	Z	Z1	Z2

X、Y、Z: Pre-test is taken by both experiment team and control team.
X2、Y2、Z2: Post-test is taken by both experiment team and control team.
X1: "Cooperative learning of online math games" is used by First Experiment Team to support math learning.
Y1: "Collaborative learning of online math games" is used by Second Experiment Team to support math learning.
Z1: Control Team uses traditional learning method.

4 Research Outcomes and Discussions

According to the experiment framework, independent sample ANOVA is employed for the posttest. Posttest data analysis reveals the differences between the two experiment groups and the control group reach the significant level as shown in Table 2. Yet post-event analysis shows the difference between the two experiment groups has not reached the significant level as shown in Table 3. Experiment outcomes indicate the two CAL teamwork models are significantly superior to the traditional teaching approach.

Table 2. Posttest ANOVA

ANOVA

GRADE

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3159.644	2	1579.822	3.224	.045
Within Groups	42138.800	86	489.986		
Total	45298.444	88			

Table 3. Post-Event Comparison of Posttest ANOVA Pairwise Comparisons Dependent Variable: Posttest

(I) 1.Cooperative 2.Conventional 3.Collaborative	(J) 1.Cooperative 2.Conventional 3.Collaborative	Mean Difference(I-J)	Std. Error	Sig. a	95% Confidence Interval for Difference	
					Lower Bound	Upper bound
1	2	10,593*	3,867	.007	2,905	18,280
	3	-3,602	3,888	.357	-11,332	4,128
2	1	-10,593*	3,867	.007	-18,280	-2,905
	3	-14,195*	3,832	.000	-21,813	-6,576
3	1	3,602	3,888	.357	-4,128	11,332
	2	14,195*	3,832	.000	6,576	21,813

5 Conclusions

This study incorporates cooperative learning and collaborative CAL with contents of elementary math and allows students of two classes to participate in the two types of cooperation. Following 4 weeks of game process, a data bank is employed to collect students' basic data in conjunction with analysis of students' pretest, posttest scores and online survey questionnaires. In accordance with research objectives and the problems to be solved, this study analyzes "Learning Achievement of Different Classes," "Learning Achievement of Different Genders" and "Learning Achievement of Different Academic-Achievers".

References

1. Marinopoulos, D., Stavridou, H.: The influence of a collaborative learning environment on primary students' conceptions about acid rain. Journal of Biological Education 37(1), 18–24 (2002)
2. Edmund, T.E., Mary, C.G.: Cooperative Learning in Elementary Classrooms: Teaching Practices and Lesson Characteristics. The Elementary School Journal 103(1) (2002)
3. Palincsar, A.S., Herrenkohl, L.R.: Designing Collaborative Learning Contexts. Theory into Practice 41(1), 26–32 (2002)
4. Lin, C.-H.: Construction and Application of Virtual School. In: 2000 International Conference on Design and Application of Middle and Elementary School Network Learning Environment (2000)

5. Huang, C.-J., Lin, P.-S.: Cooperative Learning. Wu-Nan Publication House (1996)
6. Bevilacqua, M.: Collaborative learning in the Secondary English Class. Clearing House 73(3), 132–133 (2002)
7. Johnson, D.W., Johnson, R.T.: Learning Together and Alone: Cooperative and Individualistic Learning. Prentice Hall, Englewood Cliffs (1997)
8. Puntambekar, S.: Analyzing Collaborative Interactions: Divergence, Shared Understanding and Construction of Knowledge. Computers and Education 47(3), 332–351 (2006)
9. Collings, P., Pearce, J.: Sharing designer and user perspectives of web site evaluation: a cross-campus collaborative learning experience. British Journal of Educational Technology 33(3), 267–278 (2002)

Investigating the Effects of an Adventure Video Game on Foreign Language Learning

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Abstract. Several researchers have found that video games, such as sports games and the well-known simulation game, "The Sims", can be useful for language learning. Some researchers also suggested the potential of adventure games in language acquisition; however, few studies have investigated the impact of adventure games on foreign language learning. This study aimed to examine the effects of a commercial adventure video game on foreign language learning. A group of 35 college EFL students in Taiwan were asked to play an adventure game "Bone". Students' perceptions toward this adventure game were investigated. The results showed that students considered the game helpful in improving their language skills and learning attitudes. Students also reported their enjoyment in game playing because of the game design. The findings in this study suggest that adventure games such as Bone can help college EFL students enhance their English language skills and learning motivation.

Keywords: adventure video game, language learning, game design, English as a Foreign Language.

1 Introduction

Digital video games have been very popular for several decades, and this widespread popularity increasingly attracted researchers to examine the potential of video games in education. Several researchers [7], [8], [11] highlighted the great value of video games for education. Recently, a number of studies have been conducted to investigate the effects of various types of video games on the teaching and learning of second/foreign languages. For example, deHaan[4] conducted a study to investigate Japanese acquisition through a baseball video game. The results of his study showed that the subject improved his listening and kanji character recognition.

Some researchers suggested that computer simulation games might be able to provide context-rich, cognitively engaging virtual environments for language learning. For example, Ranalli[12] investigated the impact of the Sims game on second language vocabulary learning and he found that participants made statistically significant improvements in vocabulary knowledge.

deHaan, Reed, and Kuwada[6] conducted a study on the interactivity of a PS2 music game. This study investigated to what degree video game interactivity would help or hinder the acquisition of second language vocabulary. Eighty randomly-selected Japanese university undergraduates were paired based on similar English

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language and game proficiencies. When one subject played an English-language music video game for 20 minutes, the paired subject watched the game simultaneously on another monitor. Following gameplay, a vocabulary recall test, a cognitive load measure, an experience questionnaire, and a two-week delayed vocabulary recall test were administered. Results indicated that both the players and the watchers recalled vocabulary from this music game, but the watchers recalled significantly more vocabulary than the players. The findings suggest that it is difficult for players to simultaneously pay attention to gameplay and vocabulary.

In addition to the various types of digital games mentioned above, there are several other genres of video games available, such as platform games, strategy games and adventure games[14]. According to Baltra[1], adventure games are useful tools for developing communicative fluency. In addition, in the website Successful English Learners (URL: `http://www.antimoon.com/learners/learners.htm`), Tomasz Szynalski [13] also recommended using adventure games in language learning. He suggests that adventure games can not only increase learners' motivation but help them improve their English listening and speaking skills. Within the past several years, the quality of adventure games has improved significantly. Based on these recommendations, it seems that the effects of adventure games on language learning is worthy of further investigation. Thus, this study aimed to examine the effects of commercial adventure games on English learning and to answer the following research questions:

1. What are the design and features of adventure games that EFL students like most?
2. What are the design and features of adventure games that EFL students feel most uncomfortable about?
3. What language skills and knowledge can be improved via adventure games based on students' perceptions?

2 Methodology

2.1 Subjects

The subjects of this study were 35 college students from a national university in Taiwan. The average age of these students was 19; two-thirds were female. The subjects' English proficiency level was at the intermediate level. An adventure game called Bone produced by TellTale Games was assigned as homework. Students were encouraged to install the game on their own PCs and play the game after class. After playing the game, they needed to hand in a short written report about their experience and also fill out a written survey.

2.2 Instrument

To allow students to experience adventure games, a high-quality, non-educational adventure game called Bone was purchased and provided to them. It consists of two episodes, Bone 1 and Bone 2. These games were produced by a game company in America called TellTale Games (`http://www.telltalegames.com`). The Bone game was based on the Bone comic series by Jeff Smith, recounting the adventures of three cartoon figures, Fone Bone, Phoney Bone and Smiley Bone.

These adventure games, as shown in Figure 1, have very rich language input which includes both spoken and written input. The players can simultaneously hear the dialogues spoken by English native speakers and see the English subtitles while playing. The players will engage in different demanding tasks, some of which require players to closely read the text to figure out possible solutions to current puzzles. In one task, for example, players need to complete a poem by putting appropriate metaphors into the blanks in each sentence, which require players to know the meaning of the words and what the words can be referred to (e.g., Your eyes are as blue as *a drop of dew*).

Fig. 1. A screenshot of TellTale's Bone

2.3 Procedures and Measurement

Before playing the game, the subjects were given a brief instruction on how to play the games. Since it takes several hours to complete one Bone game, the game saves previous records automatically to allow players to resume the game at the point they previously completed. The game also provided various types of hints and clues to help gamers in case they are stuck for too long. Students were given sufficient time to play the game. When students were done with the game, they were asked to write a short report about their gaming experience. They were also requested to fill out a survey which consists of 10 five-scale questions and three open-ended questions in class. The three questions are (1) What are the design and features that you like most in playing this game? (2) What are the design and feature you do not like in this game? and (3) In what way can the game help you improve your English ability?

3 Result

3.1 General Perceptions

The mean score of the ten graded statements is 3.61, and the standard deviation is 0.71. Based on the survey results, students stated that the game was helpful in improving their general English ability, listening ability, reading ability, and vocabulary knowledge, whereas the games did not help them improve speaking ability, writing ability, and grammar knowledge. As for their comments on game design, students graded the graphic design (*M*=3.93), the storyline (*M*=3.69) as well as the given instructions/hints (*M*=3.76) with high scores. The mean scores and standard deviations of each statement are shown in Table 1.

Table 1. Summary of students' general perceptions of the video game

Statements	Mean	SD
1. The graphic design of the game attracts me.	3.93	0.75
2. The storyline of the game attracts me.	3.69	0.81
3. The instructions/hints in the game are clearly given.	3.76	0.69
4. The game helps me improve my English listening ability.	3.69	0.60
5. The game helps me improve my English speaking ability.	3.00	0.85
6. The game helps me improve my English reading ability.	4.14	0.52
7. The game helps me improve my English writing ability.	3.10	0.72
8.The game helps me improve my English vocabulary knowledge.	3.83	0.80
9. The game helps me improve my English grammar.	3.17	0.60
10.In general, the game helps me improve my English ability.	3.79	0.73

3.2 Strengths and Weaknesses of Game Design

Students stated that the game was interesting to play and they liked the gameplay design the most (n=20). The identified attractive features were its challenging/diverse game missions, intriguing storyline, multiple routes, and simple operation. Eight students commented that there were various challenging missions for them to engagne in, and that they had a great sense of achievement on completion of a challenging mission; one student even reported that the challenging game missions trained his strategic thinking ability. Seven students reported that the intriguing storyline attracted them to continue playing.

Although students showed great fondness for the gameplay design, they also identified some deficiencies. For example, near half of the students complained that they were frequently stuck in the game because some of the game missions were too difficult to complete and that completing these missions took a lot of time. The identified strengths and weaknesses are summarized in Table 2.

3.3 Gains and Difficulties in Language Learning

In their written reports, most students indicated that the game helped them improve their listening ability, reading ability and vocabulary knowledge the most, which corresponded to the results of the Likert Scale (see Table 1). They stated that the written/spoken input enhanced their listening (n=18) and reading comprehension (n=10), and some mentioned the increase in reading speed after gaming(n=6). As for improvement in vocabulary, 11 students reported that the game helped them increase their vocabulary size, 6 of whom mentioned that they consulted dictionaries for new words when gaming. In addition to language gains, students also acknowledged some

Table 2. Summary of strengths and weaknesses of game design

	Strength	Weakness
Gameplay Design	• Various challenging game missions (n=8) • Intriguing storyline (n=7) • Multiple routes(n=3) • Easy for less skilled gamers to play (n=2)	• Difficult game missions (n=14) • Time-consuming (n=6)
Art Design	• Appealing graphic/character design (n=17)	
Audio Design	• Clear dubbing (n=4) • Good background music (n=2)	
Others	• Sense of achievement (n=8) • Development in strategic thinking (n=1)	

positive influences on learning attitudes developed through the game. Eight students reported that they enjoyed learning English through gaming and indicated that gaming could enhance their motivation and make learning more entertaining. Some also reported the gain of a sense of achievement when they were able to fully comprehend the dialogues in the game. Several students also mentioned that playing English video games provided them the opportunity to be in an all-English environment, which forced them to think in English.

Table 3. Summary of gains and difficulties in language learning

	Language/Learning Gain	Language Difficulty
Listening	• Improvement in general listening ability (n=18)	• Fast speaking speed (n=5)
Reading	• Improvement in general reading ability (n=10) • Increase in reading speed (n=6)	• Fleeting subtitles (n=2) • Unfamiliar abbreviations (n=1) • All letters are capitalized (n=1)
Vocabulary	• Increase in vocabulary size (n=11) • Moderate difficulty level (n=3)	
Colloquial Usage	• Acquisition of more colloquial usages (n=4)	
Learning Attitude	• Enjoyment in English learning (n=8) • Increase in learning motivation (n=2)	
Others	• Sense of achievement (n=3) • All-English environment (n=3)	• Difficulty in concentrating on language learning (n=2)

Although students achieved some improvements in English through gaming, they still recognized several language difficulties that hindered their gaming as well as learning. First, some of them complained that the fast talking speed of the dialogues as well as the fleeting subtitles caused them difficulty in language comprehension. Other features that caused difficulties in language comprehension included a large number of unfamiliar abbreviations and reading in all capitals. In addition, two students reported the difficulty in focusing on language learning while gaming. They stated that their attention was engaged in accomplishing the game missions rather than in acquiring the language. Table 3 summarized the language gains and difficulties identified by students.

4 Discussion

Based on the survey results and written comments, it was found that the students held positive attitudes toward the game design, which supports findings from previous studies on games in education in that using games in learning is fun and can enhance learners' learning motivation [3], [4], [12]. In this study, the storyline and art/audio design were attractive to students. As presented in previous section, the storyline as well as art/audio design attracted students to continue playing the game, which conformed to Gee's Design Principle [7]. Moreover, the intriguing storyline was one of the most salient strengths of the game, which echoes the similar finding reported in Chen and Yang's [3] study.

Another critical factor that could influence students' perceptions of the attractiveness of an adventure game is whether the game missions are challenging enough for students and thus provide them a sense of achievement upon completion. The importance of challenging game missions was earlier identified by Malone [10] and is again supported in this study. Many students reported the challenging game missions were very engaging and their engagement was further reinforced by the sense of achievement gained upon the completion of the missions. However, it should also be noted that what was challenging to certain students might be difficult to others. As mentioned in previous section, many students complained that some missions in Bone were too challenging and that they spent much time on these missions. If the difficulty level of game missions is beyond the students' competence, it might take students a great amount of time and thus runs the risk of losing students' interest. Thus, teachers should select games suitable to students' ability in order to sustain students' interest in gaming.

Based on students' written reports, several students pointed out that the language in Bone games was not very difficult to understand, but the task design was more challenging. Students reported that even though they could fully comprehend the text when gaming, they sometimes still had no idea what they should do to complete a mission. Interestingly, even though students complained about some difficult missions, they still wanted to keep on playing in order to know how the story would go. It seemed that students' interest in the storyline and their perseverance provided them motivation to overcome the frustration resulting from the difficult missions.

In addition to positive feedback on the game design, language improvements were also reported both in the survey and open-ended questions. This finding supported

Szynalski's argument that when playing adventure games the players are "programming their brains with good English". It seems clear that adventure games can enhance learners' listening and reading abilities by exposing them in an environment full of written/spoken language input. Similar findings were reported by other studies [2], [3]. Moreover, students also stated that they acquired more vocabulary items after gaming [2], [3], [6], [12]. Some students even voluntarily consulted dictionaries for new words, showing their high involvement in self-learning while gaming; this agreed to Halstijnand Laufer's [9] argument of "learner involvement" being the main factor influencing overall effectiveness in language learning. In this case, students had the need to know the meaning of a new word, found a way (dictionary use) to search for the answer, and evaluated the correctness of the answer by putting it back into the context. It seemed that the game could involve students in both gaming and learning; however, a few students stated that their high involvement in gaming led to less attention on the language, revealing that high interactivity in the game somehow hindered students' learning [5], [6]. It is thus worthwhile to investigate how and to what extent interactivity in adventure games can influence language learning.

Several problems emerged when using adventure games like Bone. Students complained that there was no way for them to control the dialogues and subtitles. As a result, the fast dialogues and fleeting subtitles caused them some difficulties in comprehending the text. In fact, this "lack of control" in subtitles and dialogues has already been identified by deHaan[5]. He criticized that, in most adventure games, the dialogues could not be paused by players and it was thus troublesome for players to decode the language. The game design can be further improved in this aspect.

5 Conclusion

As a preliminary study on the use of adventure video games in foreign language learning, several limitations should be noted. First, no pretest and posttest were implemented to examine students' language improvements after using the video games, it is thus expected that more rigid evaluation of students' language gains after gaming will be carried out in future research. In addition, there are various types of adventure games available. Each game has different contents and levels of language difficulty, and thus it is important to further explore whether certain types of adventure games are more effective than other games.

Regardless of the limitations, this study has provided evidence that, even though some difficulties and inconvenience might occur while gaming, language learners still hold positive attitudes toward the use of commercial adventure games in language learning, and that this type of games are possibly beneficial to learns' improvements in listening, reading, and vocabulary knowledge. The results in this study thus suggest the educational potentials of adventure video games for foreign language learning and should encourage further exploration into how and to what degree such games can assist learners in enhancing the identified language aspects.

References

1. Baltra, A.: Language learning through computer adventure games. Simulation & Gaming 21(4), 445–452 (1990)
2. Chen, H.-J., Huang, W.: Examining the potentials of computer games for English learning. In: 3rd IEEE International Conference on Digital Game and Intelligent Toy Enhanced Learning, pp. 134–138. IEEE Press, Los Alamitos (2010)
3. Chen, H.-J., Yang, C.: Investigating the effects of an adventure video game on vocabulary learning. Paper presented at the meeting of International Conference on Joyful E-Learning, Kenting, Taiwan (2011).
4. de Haan, J.W.: Acquisition of Japanese as a foreign language through a baseball videogame. Foreign Language Annals 38(2), 282–286 (2005a)
5. de Haan, J.W.: Learning language through video games: A theoretical framework, an evaluation of game genres and questions for future research. In: Schaffer, S., Price, M. (eds.) Interactive Convergence: Critical Issues in Multimedia, pp. 229–239. The Inter-Disciplinary Press (2005b)
6. de Haan, J.W., Reed, W.M., Kuwada, K.: The effect of interactivity with a music video game on second language vocabulary recall. Language Learning & Technology 14(2), 74–94 (2010)
7. Gee, J.P.: What videogames have to teach us about learning and literacy. Palgrave Macmillan, New York (2003)
8. Gee, J.P.: Good video games and good learning: Collected essays on video games, learning and literacy (New literacies and digital epistemologies). Peter Lang Publishers, New York (2007)
9. Hulstijn, J.H., Laufer, B.: Some Empirical Evidence for the Involvement Load Hypothesis in Vocabulary Acquisition. Language Learning 51(3), 539–558 (2001)
10. Malone, T.: Toward a theory of intrinsically motivating instruction. Cognitive Science 4, 333–369 (1981)
11. Prensky, M.: Digital game-based learning. McGraw Hill, New York (2001)
12. Ranalli, J.: Learning English with The Sims: Exploiting authentic simulation games for L2 learning. Computer Assisted Language Learning 21(5), 441–455 (2008)
13. Szynalski, T. P.: Learning English with adventure games, `http://www.antimoon.com/how/advgames.htm`
14. Whitton, N.: Learning with digital games. Routledge, New York (2010)

Employing Software Maintenance Techniques via a Tower-Defense Serious Computer Game

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Abstract. In this paper we address the problem of the stereotype which portrays a software engineer as one who spends his or her whole day in a cubicle programming. We present an interactive, real-time strategy, tower defense game, to help students ranging from middle school to college juniors learn about the maintenance phase of the software engineering life cycle. Specifically, our game educates students about the four forms of software maintenance: adaptive, corrective, perfective, and preventive. The important aspect of our game is that the student does not actually perform software maintenance, which could be an abstract and intimidating process. Instead, the student plays a real-time strategy, tower defense game which is appealing especially to a younger audience. The key is the student is still using the same strategies that would be used in a real software project to perform software maintenance to complete our game.

Keywords: Edutainment, Middle School Education, Software Engineering Education, Software Maintenance.

1 Introduction

One of the important objectives of our game is to educate middle and high school students about software engineering discipline, so they do not believe nor accept popular stereotypes, such as the one portraying a software engineer as one who spends her whole day in a cubicle programming. In addition, we strive to prepare college students to better understand concepts taught in a software engineering course. We selected to incorporate key software maintenance concepts in our game, as this is one of the most expensive and often overlooked phases in the software engineering lifecycle. Younger audiences find our real-time strategy, tower-defense game very appealing, as it is engaging, immersive, and fun. We use metaphors to simulate similar strategies that would be used in a real software project to perform software maintenance. Other educational software engineering games simulate general aspects of software engineering from a project management perspective [1,2].

Educational games are successful when both inexperienced and experienced students can learn from playing the game [3]. We accomplish this in our game, as middle and high school students do not fully understand computer science or software

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engineering, but it still enables them to relate to the high level strategies and techniques used. At the same time, our game allows undergraduate students to reinforce concepts taught in a software engineering lecture about software maintenance. Basawapatna et al. developed a system where students learn computational thinking patterns through developing games on their own. Their approach requires significant teacher time, as students need to be taught how to develop their games. Computational strategies are basic concepts about computer science, generally covered in a freshman fluency course. By playing our game, students learn higher level, more complex concepts, as students are being exposed to key software engineering principles. With our approach, teacher time is minimal, as students become immersed in the environment that we have created for them and ultimately learn from the experience mostly on their own. Moreover, our game is available to any student, whereas having students develop their own games has limitations on the target audience.

2 Game Description

Students are able to learn much more from a game that is immersive [4]. We ensure that this occurs in our game, as the student must successfully beat a tower-defense game, which is a subgenre of real-time strategy games. The goal is to try to stop enemies from crossing the map by building towers which shoot at them as they pass. The enemies and towers usually have varied abilities and costs. When an enemy is defeated, the player earns money, which is used to buy more towers. In our game, the student is faced with ants, which are a metaphor for software bugs and lacking features for an existing software system. The student is able to place towers to eradicate these bugs (see Figure 1). The student has two options for towers: fly swatter and insecticide. The fly swatter will deal heavy damage to a single tile on the path, but its attack time is slow. The insecticide deals less damage, but repeatedly attacks all neighboring tiles. The student starts with 75 points. The fly swatter costs 10 points and the insecticide costs 20 points.

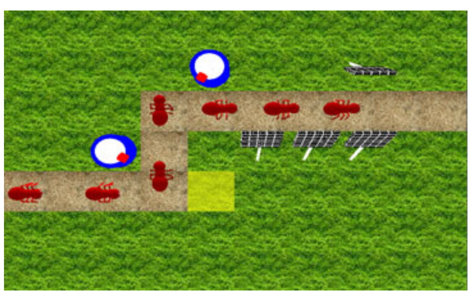

Fig. 1. The student must destroy all of the bugs by placing towers

Each ant that is able to cross the path costs the user 10% health. The first and second levels use the same board layout, but the second level has a larger wave of ants which move at a faster pace. Once the second level has been completed, the student is awarded 50 additional points. Third and fourth levels use a new board layout, completely resetting the board, which means all towers are destroyed before the level starts (see Figure 2). Similar to levels one and two, the fourth level has a larger and faster wave of ants than level three. Once level four has been finished the player has won the game. If the student reaches 0% health, he or she has lost the game and will have to restart. Four levels are presented here, but additional levels and difficulties can be added quite easily through the use of an input file.

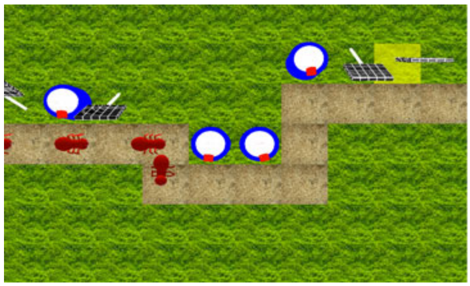

Fig. 2. The student must adjust their strategy when the level changes

If the student places a tower in the wrong location they face the consequences of their decisions. The student needs to reposition the tower in order to correct his or her mistakes. The student is allowed to destroy a tower, but he or she will only be credited back 5 points. This approach teaches students to spend their points wisely on towers. If all points are credited back, there would be no incentive for thinking while playing the game and developing a good strategy. This allows students, however, to try new ideas and not be completely penalized. It enables students to adapt to change, correct their mistakes, perfect their strategy, and further prevent more ants from exiting the level. These concepts, which our game provides, highlight the four forms of software maintenance. The goal of our game is to educate students on the four forms of software maintenance: adaptive, corrective, perfective, and preventive.

2.1 Adaptive Maintenance

Adaptive maintenance enhances a software system by reactively adapting it to allow for a change in a system or system environment without providing additional capabilities. An example of adaptive maintenance is the following scenario:

> You own a game company and you have recently released a role-playing game. The game is very good, but reviewers claim that the game could have more features, such as more levels, more characters, and more items. You will need to alter and change this game in order to make your customer base happy through the release of a patch. What type of maintenance would you need to perform?

This is represented in our game, as the varying speed and size of ants in each wave causes the student to adapt to change in our game. As the game progresses throughout each wave, the adaptability is achieved by quickly responding to the environmental change with the strategic placement of towers with requirement to defend the map. The availability of only a select number of towers is representative of code reuse with limitation of only current capabilities. For example, the use of the fly swatter and insecticide towers can be placed and positioned in tandem to successfully adapt to the onslaught of the approaching wave. Educational games with effectively applied incentives provide the key effect of exposing players to a growing learning content that is embedded in the various game activities, which in turn motivates them to acquire further knowledge and continuously improve on these skills [5]. Our analogy asserts the adaptation of code respective to the changing software requirements and ultimately reinforces to the student that bugs are fixed when they are discovered and solidifies to the student the importance of code reuse with rapidly changing needs.

2.2 Corrective Maintenance

Corrective maintenance focuses on the elimination of existing bugs by injecting code into an existing program designed to fix these known bugs. An example of corrective maintenance is the following scenario:

> You are a software developer for a large bank. Your staff recently deployed an online banking application to the public. The system was developed according to your requirements, but someone didn't double check their work when developing how transactions work. Unfortunately, when users perform transactions through your application, it deposits or withdraws the incorrect amount of money. A lot of money has been lost, and this issue needs to be fixed. Which type of maintenance will your staff have to perform?

This is reflected in our game via the dismantling of towers to allow for superior defenses to be arranged. These defenses are either a repositioning of the defensive line or more effective towers. For example, a swatter may be placed at a bend in the path, but this tower only attacks one square at a time, whereas replacing it with an insecticide tower allows for the entire bend to be affected by a single attack. The student learns from the decisions made during the course of the game and so is capable of correcting past mistakes using this technique, which achieves this goal as well as the overarching goal of reinforcing the necessary abilities attributed to corrective programming.

2.3 Perfective Maintenance

Perfective maintenance, unlike adaptive maintenance, is proactive and enhances the system by improving overall efficiency, reliability, functionality, as well as maintainability as it attempts to fix the system before the event of a failure. An example of perfective maintenance is the following scenario:

> You developed a complex program, which performs a lot of complex math. This program takes a long time in order to produce an output. The program does what it is suppose to do and is very accurate, but customers want it to run faster. What type of maintenance will you need to perform in order to please your customers?

Our game simulates this with the notion of not allowing any enemy bugs to reach their destined goal. The idea behind this representation is centric around preplanning the strategic placement and positioning of the towers respective of the current wave of enemy bugs. These placements define the overall efficiency of the towers when targeting oncoming bugs, as well as determine the reliability of the tower with relation to the relative position. If thought is not put into perfecting the tower layout, prior to the approaching enemy bug wave, efficiency, reliability, as well as the functionality of the defending tower will be compromised and an enemy bug will reach the goal signaling failure. A good educational game should address both the student's psychological needs and critical thinking in order to develop the student's cognitive ability [4]. The student is able to establish the concepts of perfectively maintaining software systems as it relates to the preplanning, prevention, and detection of unexpected system exceptions or erroneous code that may lead to unexpected failures.

2.4 Preventive Maintenance

Preventive maintenance is the modification of a software product after delivery to detect and correct latent faults in the software product before they become effective faults. An example of preventive maintenance is the following scenario:

> Your company has a dedicated server which runs 24/7. After several days, this dedicated sever starts to become less reliable, as various services will start to crash, won't work correctly, or will run slow. It has been determined that this dedicated server will be rebooted nightly and all newly created files will be backed up. We want to avoid future problems, so what type of maintenance is this considered?

The analogy of preventive maintenance in our game is the strategic placement of towers to destroy the enemy before reaching their goal. The reasoning of the analogy is that the enemy is representative of faulty input states, which are being processed along the path. If these bugs reach their goal, they are reaching program output, creating an invalid state in the system, of which only a limited number of faults are tolerated, indicated by the health counter, which upon reaching zero the program reaches an intolerable state and the game ends in failure. The towers along the path represent the defensive measures taken to prevent these faulty states from corrupting the state of the program. Students' decisions have a long-term impact: poor planning will allow many bugs to get through, resulting in little chance of surviving the onslaught of insects, which will enforce careful decision-making by the student in subsequent sessions.

3 User Study

Three user studies were conducted to determine the effectiveness of our game in metaphorically teaching players concepts of software maintenance in software engineering. Each user study consisted of different audiences: middle school-aged, high school-aged, and undergraduate students enrolled in a junior-level software engineering course in Computer Science Department at Rowan University.

For each audience, each player was given instructions and was allowed to play the game until he or she finished it. After finishing the game, each player had to fill out a questionnaire. The questionnaire asked the player whether he or she beat the game, how many attempts did it take to beat the game, and if they had fun playing the game. In addition, we asked why it is important to adapt to change, correct tower placement, improve and perfect strategy, develop a preventive strategy when playing the game. Each of these questions relate to one of the four forms of software maintenance. We wanted to see what connections were made between our game and the different forms of software maintenance. Furthermore, we provided four multiple choice questions to determine if students learned the role and purpose of each form of software maintenance. Each question was the hypothetical real-world software situations mentioned earlier in this paper, in the sections that define each maintenance type. Each question had four options, which were the four forms of software maintenance, from which the students had to choose one of them as their answer. If students are able to play our game and then accurately associate the correct form of software maintenance with a particular problem space, then they are grasping the fundamental concepts of software maintenance and our game has accomplished its goal.

In the first case study, eighteen seventh grade middle school students played the game. None of these students had prior experience with the software engineering process. This audience was chosen to see if the game could successfully make these children aware of the software engineering process and how software engineering differs from computer programming. In the second case study, ten high school students played the game. This audience was chosen to see if the game could successfully make these students aware of the software engineering process and teach them about the basics of software maintenance. In the third case study, thirteen (mostly juniors) undergraduate students played the game. At the time of our study, these students were registered in an undergraduate course titled "Software

Table 1. Table describing the success rate of students beating our game

	Middle School	High School	Undergraduate	Mean	Std. Dev.
Students who beat the game	94.44%	80.00%	100.00%	91.48%	10.32%
Students who required more than three attempts to beat the game	17.65%	37.50%	7.69%	20.95%	15.18%

Engineering I”. All of these students are computer science majors, but have no previous experience with software engineering projects or fundamentals. This audience was chosen to determine if this game could effectively help teach software maintenance fundamentals in an academic setting. If successful, the game could be incorporated into the future curriculum of this course.

With the exception of two undergraduate students, the rest of the students said that they enjoyed playing the game. They discussed how our game was immersive and that they had a great time playing it. Four high school students and three undergraduate students said that they cannot wait to see the second version of this game with more levels, towers, and enemies. Two high school students and four undergraduate students mentioned that they had fun playing our game because they could see how it relates to software engineering. These students saw that it is important to develop a good strategy and approach in this game, much like in the software maintenance process. Almost every middle school student said that they liked our game because it was entertaining, fun, and challenging. Several of these middle school students said they liked a challenge, as it required them to use their brain, which makes the game even more engaging. A couple students mentioned that they like strategy games and they liked the simplicity in the setup and presentation of our game. One middle school student said that he liked our game as, “it is different from other tower defenses, which made it really fun to play”.

When asked why it is important to adapt to change and correct tower placement, the students gave very interesting answers. Almost every middle school student said that as our game gets harder, it is important to adapt to change. Two high school students and five undergraduate students took their analysis a step further and said that this process resembles software maintenance, as poor software maintenance is costly since more bugs reach the end-user.

The students gave positive responses to how to perfect their strategy and how a preventive, defensive strategy can prove to be beneficial. Students mentioned that it is important to have a defensive and preventive mindset, as if their strategy does not take into account all possibilities, some ants could sneak through and exit the level safely. Two high school students and four undergraduate students related this to software maintenance, as ants exiting the level safely resembles bugs not addressed by software developers.

Table 2. Table describing how many questions were correctly answered by the students

	Number of Students	Total Questions Answered	Questions Answered Correctly	Percentage
Middle School	18	72	34	47.22%
High School	10	40	32	80.00%
Undergraduate	13	52	46	88.46%
Grand Total	41	164	112	68.29%

The overall results of the multiple choice questions relating to the real-world scenarios, presented in the software maintenance sections earlier in this paper, generally validated our goals. Middle school students had difficulties associating adaptive and perfective maintenance with the correct question, as fourteen and twelve students incorrectly answered these questions, respectively. There were some time constraints in our middle school user study, so with more time, the students might have answered a higher percentage of the questions correctly. One high school student and one undergraduate student confused corrective and adaptive maintenance and had their choices flipped on those two questions. Three high school students and two undergraduate students confused perfective and preventive maintenance and had their choices flipped on those two questions. The majority of time students were able to relate metaphors in our game with the software maintenance process and were also able to learn about the four different forms of software maintenance. The user study demonstrates that these students were generally able to associate the correct form of maintenance with a particular real-world problem.

The middle and high school students really enjoyed themselves while playing. Almost all of these students were smiling, laughing, and actively engaging the game. Middle school girls seemed to enjoy the game as much as the boys. Discussion was present between some students, as they were asking one another for suggestions on how to improve their strategy. Several high school students personally came up to us after the user study and wanted to know more about software engineering, software maintenance, and what they should do now in order to be accepted into a computer science program at a four-year university.

The results we obtained from all three user studies validate the underlying foundation of our game, which is to engage students in an educational game which metaphorically exercises activities similar to those exercised during the software maintenance process. The middle school and high students gained a new appreciation for software engineering and learned the basic aspects of software maintenance. This game laid the groundwork for these students not to accept the typical stereotypes surrounding software engineering. The undergraduate students now are better prepared for software maintenance. Software engineers need to be creative and adapt to constant change. It was great to observe students adapting to change in our game and coming up with their own unique approaches for being victorious.

4 Conclusion

In this paper we have presented a metaphor-based tower-defense serious computer game for educating students about software maintenance in the software engineering life cycle. Students realized that their strategy must constantly change when playing a tower defense game and that this same notion applies to software maintenance.

Middle and high school students develop a new appreciation for software engineering, which allows them to make a more informed decision when considering it as their future profession. Our game could be an effective part of teaching software maintenance in an entry level software engineering course, not as a replacement of coursework or lecture material, but for introducing or reinforcing key concepts.

Our user study required students to answer multiple choice questions about different software maintenance problems. The goal was to see if the students could relate the four different forms of software maintenance to the correct problem, as experienced in the game. None of these students knew what the four different forms of software maintenance were before playing our game. In total, 47.22% of middle school, 80.00% of high school, and 88.46% of undergraduate students from our study answered the questions correctly, which shows that our game is educating these students on the maintenance phase of the software engineering life cycle.

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References

1. Oh, E., van der Hoek, A.: Multi-Site Evaluation of SimSE. In: Proceedings of the 40th ACM Technical Symposium on Computer Science Education (2009)
2. Rusu, A., Russell, R., Robinson, J., Rusu, A.: Learning Software Engineering Basic Concepts using a Five-Phase Game. In: Proc. 40th Annual ASEE/IEEE Frontiers in Education Conference (2010)
3. Basawapatna, A.R., Koh, K.H., Repenning, A.: Using scalable game design to teach computer science from middle school to graduate school. In: Proceedings of the Fifteenth Annual Conference on Innovation and Technology in Computer Science Education, pp. 224–228 (2010)
4. Yue, W.S., Zin, N.A.: Usability evaluation for history educational games. In: ACM International Conference Proceeding Series: Proceedings of the 2nd International Conference on Interaction Sciences: Information Technology, Culture and Human, vol. 403, pp. 1019–1025 (2009)
5. Bellotti, F., Berta, R., De Gloria, A., Primavera, L.: Enhancing the educational value of video games. In: Computers in Entertainment (CIE) - SPECIAL ISSUE: Media Arts and Games (Part II), p. 7 (2009)

Playing Webcomic-Based Game on Facebook for Learning Chinese Festivals

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Abstract. People nowadays have acquaintance with living on social network sites hence it is worth of providing them a learning environment where is embedded in SNS that they can do what they have been already familiar with. In addition, Reading comics or webcomics will give learners enjoyable and positive experiences. The researchers create the four-frame Webcomic-based game on Facebook for learner who has eager to learn about and interest in Chinese Festivals by gaming. This paper adopts and refers to the game design guidelines which are addressed by previous research in order to create a game which learners feel comfortable with. The game rules and designs are addressed in this paper on the basis on literature reviews. Eventually, after determining the construction of game content, the social interactive design combining with Facebook should be more concerned about.

Keywords: Game-based learning, Facebook games, Webcomics, Chinese festivals.

1 Introduction

From gaming individually to gaming socially, games on Facebook have been growing in an increasing number at present. On account of the interaction form of new generation has been changed – interacting with friends by using applications or games on Facebook in their daily life – , this social network site (SNS) has given us the opportunities of playing and learning [1]. Speaking of learning potential of social network games (SNGs), people are encouraged to play them stem from inviting friends to play and completing the tasks together [2]. People nowadays have acquaintance with living on SNS hence it is worth of providing them a learning environment where is embedded in SNS that they can do what they have been already familiar with.

Reading comics or webcomics will give learners enjoyable and positive experiences, and webcomics are available through the Internet readily. The presentation way of comics let readers can quickly perceive a conception at a glance, and lots of learners are familiar with the structure of comics that makes their reading more effective and memorable [3]. On the basis of the above-mentioned advantages, the researchers create the four-frame Webcomic-based game on Facebook for learner who has eager to learn about traditional culture and interest in Chinese Festivals by gaming.

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More specifically, the researchers focus on how much learner's learning effect and engagement through playing the game which is combined with webcomics on Facebook. Furthermore, utilizing the specific features of Facebook games, learners are allowed to share experiences and interact with their friends in a handy way that can motivate learners to play games with educational contents entertainingly and continuously [4]. This paper adopts and refers to the game design guidelines which are addressed by previous research in order to create a game which learners feel comfortable with. The main research questions to be addressed as follows:

- Does learner obtain knowledge effectively by playing the game with educational purpose on Facebook?
- How much knowledge can learner transfer into the reality that would be helpful for them?

2 Literature Review

2.1 Game-Based Learning

Based on the popular of game-based learning, teaching materials were reorganized and designed into games most often. Learners can be motivated and gain positive attitudes while they do learning by gaming [4]. A well-designed game with educational purpose provide learners both education and pleasure, in addition, learners hardly mention that they attend an instruction which has been transformed into game context as they in a receptive game environment [5]. Apparently, games are not only adapted to be the informal learning materials which learners can gain the knowledge incidentally, but also the learning contents can be transferred to required skills into the reality [6].

Mostly the information of Chinese Festivals is introduced on websites with texts and images that learners are hard to hold their patience unavoidably while learning the contents by reading. In this reason this paper adopts Chinese Festivals as the topics of the four-frame Webcomic-based game in order to create a virtual environment for understanding the tales and relative activities of each festival. The expected outcome is what learners obtained from the game can be capable of blending into real world.

2.2 Characteristics of Facebook Games

Applications on Facebook attract learners to hook on playing games with their friends due to the powerful social networking. Rao [7] stated that those applications on Facebook usually should be defined as "casual games." The characteristics of casual games are "easy to learn, online, no multitasking, for all, fast rewards, forgiving the player error, simple control and simpler gameplay (sometimes just one click)" [8]. The trend of gameplay incline to browser-based, lightweight applications and free-to-play in order to engage users who like the game experience "snack gaming" (spend few minutes to play but frequently) in playing games [9]. Besides, learners are allowed to share their gaming experiences, achievements, requests, gifts and other feedbacks with friends. Furthermore, they will be motivated to play games by the posts from friends as well.

2.3 Webcomics

Webcomics are displayed, created on the Internet and deal with the issues that different from mainstream comics [10]. Several studies have conducted the learning environments by using webcomics. Costello and Bilton [11] developed visual storytelling webcomic as a motivating tool for learners to learn about anthropology. Depicting stories can put learners deeply into the situations that they will suppose themselves as the story characters. Similarly, stories can present contexts which are based on the reality and be regarded as training simulations [12]. Combining game with webcomics is the way to attract learners' attentions and encourage them deep into the contexts with learning materials.

3 Game Design

3.1 Rules

Primarily the researchers created four-frame webcomics of six Chinese Lunar Festivals as the storylines of the game. At first, learner only can choose one of the six webcomics to read (others will be locked), and find the inappropriate elements in each comic frame, i.e., picking the element – red envelope – out in comic Dragon Boat Festival on account of this element should not be appeared here. The elements learner has found will be categorized into a collection book that learners can check for more detail information about them any time. After finishing the first webcomic, game will unlock the rest in succession according to the assigned tasks are completed. Learners are requested to collecting all the representative elements of the festivals for accomplishing the collection book. Undoubtedly they can share their achievements or post invitation on the wall of Facebook.

Different from collecting the right elements of each festival simply, the four-frame Webcomic-based game put the wrong elements in each festival webcomic which learners will take notice of actively. This kind of gameplay makes learners more concentrate on immersing into the contexts. Not only reading the stories about festivals but also acquiring the knowledge of representative elements meaningfully.

Most importantly, what learners have learned in the game can be applied to their daily life while confronting Chinese Festivals. Gentile, Anderson, Yukawa, Ihori, Saleem, Min, Shibuya, Liau, Khoo, Bushman, Rowell Huesmann and Sakamoto [13] found that employing prosocial content into games can be more helpful after learners' playing.

3.2 Design Guidelines

Ang, Avni, and Zaphiris [14] had unified the game design guidelines from extensive studies into six categories. This paper adopts some guidelines which are appropriate with the contexts of the game as designing standards (see Table 1).

The expected development is creating the four-frame Webcomic-based game based upon the design guidelines above for ensuring quality of learning experiences from learners.

Table 1. The application of guidelines from six categories

Category	Guideline	Application in this paper
Play	• Rewarding learners by increasing their capabilities. • Tasks should be appropriate to learners' level and provide appropriate feedback while accomplished.	• Unlocking more webcomics after learners' accomplishment. • The inappropriate elements will increase while finishing more webcomics, and the game will give the trophy to learners after finishing each webcomic.
Interface	• Graphic design should be simple and easy to navigate.	• The webcomics are presented with iconic images, cute appearances of characters and vivid colors.
Rules	• Game representation should mach its counterpart in real world if the content is based on the reality.	• The webcomics use metaphors from the reality that learners can transfer them into real world.
Narratives	• The storyline should attract learners' interests make them involved in the context.	• Stories in the webcomics are based on realistic festivals. Learners can relate their learning to real life.
Social aspects	• Social support about the content should be provided.	• Learners can share knowledge and experiences with friends on Facebook.
Learnability	• Providing learning tasks that learners would immerse in.	• The tasks are related to the learning goals – understanding Chinese Festivals – closely

4 Next Steps

Determining the games and comics which provide learners with positive learning attitudes, and the construction of the four-frame Webcomic-based game content, the social interactive design combining with Facebook should be more concerned about. It have been identified that Facebook have potential to be educational tool with its features [15] and learners will benefited from educational games while they interact with others on Facebook continuously [4]. Creating new form of play to evaluate whether learners can perceive knowledge about Chinese Festivals with playful mood and take the knowledge into daily life are the essential issues of this paper.

References

1. McClard, A., Anderson, K.: Focus on Facebook: Who Are We Anyway? Anthropology News 49(3), 10–12 (2008)
2. Sung, J., Bjornrud, T., Lee, Y.H., Wohn, D.Y.: Social Network Games: Exploring Audience Traits. In: 28th of the International Conference Extended Abstracts on Human Factors in Computing Systems, Atlanta, Georgia, USA (2010)
3. McCloud, S.: Understanding Comics: The Invisible Art. HarperCollins Publishers, Net York (1993)
4. Donmus, V.: The use of social networks in educational computer-game based foreign language learning. Procedia Social and Behavioral Sciences 9, 1497–1503 (2010)
5. Steinberg, M., Brehm, J.: Social educational games based on Open Content. In: International Conference on Intelligent Networking and Collaborative Systems, Barcelona, Spain (2009)
6. Wheeler, S.: Connected Minds, Emerging Cultures: Cybercultures in Online Learning. Information Age Publishing, Charlotte (2009)
7. Rao, V.: Facebook applications and playful mood: the construction of Facebook as a "third place". In: 12th International Conference on Entertainment and Media in the Ubiquitous Era, Tampere, Finland (2008)
8. Kuittinen, J., Kultima, A., Niemela, J., Paavilainen, J.: Casual games discussion. In: 2007 Conference on Future Play, New York, NY, USA (2007)
9. Chang, T.: Gaming will save us all. Communications of the ACM Archive 3(53), 22–24 (2010)
10. Fenty, S., Houp, T., Taylor, L.: Webcomics: The Influence and Continuation of the Comix Revolution. ImageTexT: Interdisciplinary Comics Studies (2004), `http://www.english.ufl.edu/imagetext/archives/v1_2/group`
11. Costello, R., Bilton, D.: Assessment of Educational Visual Storytelling at the Smithsonian. In: Interservice/Industry Training, Simulation, and Education Conference, in Orlando, Florida, USA (2009)
12. Heath, C., Heath, D.: Made to Stick: Why Some Ideas Survive and Others Die. Random House, New York (2007)
13. Gentile, D.A., Anderson, C.A., Yukawa, S., Ihori, N., Saleem, M., Min, L.K., Shibuya, A., Liau, A.K., Khoo, A., Bushman, B.J., Rowell Huesmann, L., Sakamoto, A.: The Effects of Prosocial Video Games on Prosocial Behaviors: International Evidence from Correlational, Longitudinal, and Experimental Studies. Personality and Social Psychology Bulletin 35(6), 752–763 (2009)
14. Ang, C.S., Avni, E., Zaphiris, P.: Linking Pedagogical Theory of Computer Games to Their Usability. International Journal on E-Learning 7(3), 533–558 (2008)
15. Mason, R.: Learning Technologies for Adult Continuing Education. Studies in Continuing Education 28, 121–133 (2006)

Old Dogs Can Learn New Tricks: Exploring Effective Strategies to Facilitate Somatosensory Video Games for Institutionalized Older Veterans*

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Abstract. The purpose of the study is to explore the possibility of utilizing somatosensory video games (SVGs) to promote institutionalized older veterans to participate regular exercises in senior institutions. A total of 58 participants (82.4±4.1 years) were voluntarily willingly to participate this study in Taoyuan Veterans Home, Taiwan. Veterans aged 75 years or older, without physical disabilities and visual impairments that may interfere with the accessibility of playing the game, were recruited to participate. Exclusion criteria were also executed to ensure their safety and to decrease the drop-out rate of participation. Individuals with wheelchair, having plans for travel or extended leave of absence, intensive hospital care, or enrolling in other exercise/rehabilitation programs were excluded with euphemistic explanation. Twenty-three veterans (mean age=82.4 years, SD=3.9, range=77~91) were selected and voluntarily completed 30-minute Wii Fit Plus (Taiwan Edition) for 3 time/wk for 8 weeks. Participation observation and informal conversation were two major qualitative research methods to collect responses and feedback of veterans who participants SVGs, co-workers, and facilitators. Constant comparison was utilized to analyze the qualitative information with QSR Nvivo7. The results identified that immediately feedback, competition, companionship, challenges, close to grandchild and fun are six main reasons to attract older veterans to keep involved with SVGs. Additionally, adding extra workload for staff, no interest in high-tech, game control/operation and amotivations for learning new things are four challenges to promote SVGs. The finding showed that SVGs are viable way to attract institutionalized older veterans to participate physical activities. However, further individualized programs and assistance in control and selections are needed to continue their involvement. The study implicates that enjoyment, social interaction and flow experience are keys to develop successful SVGs sessions for institutionalized older veterans.

Keywords: somatosensory video game, Wii Fit Plus, Elderly, leisure, recreation, health promotion, balance, technology, aging, aged, physical activity.

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Learning English with Online Game: A Preliminary Analysis of the Status of Learners' Learning, Playing and Interaction

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Abstract. Recently, studies regarding status of learners' learning, playing and interaction in online educational games with situated-learning strategy were very limited. This study conducted a preliminary analysis of the learning status of a multiplayer learning online game embedded with speech recognition techniques for English teaching. We conducted an analysis of learners' long-term operational records in this game to explore learners' status of learning, interaction, and playing, and relevant discussions were provided as references for future studies.

1 Introduction

In recent years, multiplayer online games were popular with the public; also, the types of game development became more and more diverse. Until now, many educational technology researchers gradually explored this kind of game's instructional influence and potential [2,3,4]. The elements of digital games such as goals, rules, competition, challenge, fantasy, and entertainment etc. [1] were beneficial to the provision of learning motivation. Deeply analyzing learners' operational processes in educational online games and exploring their status of learning, playing, and interaction would be helpful to explore the characteristics and limitations on the application of this kind of game to instruction; and further, to provide as references for future designers and teachers. The studies regarding this aspect were still insufficient to date, and more empirical observations and analyses were needed.

This study conducted a preliminary analysis of the status of learning by aiming at a multiplayer online learning game, Talking Island (http://http://www.talking-island.com). This game integrated theory of situated learning. Players can move their own game-characters in the situated learning setting (e.g., streets and roads in urban districts) and interact with other players and Non-Player Characters (NPCs) to carry out the tasks of language learning. During the process of carrying out the tasks, players needed to practice pronouncing vocabulary, phrases, or sentences. The system would make a diagnosis through an instant speech recognition technique to make a formative evaluation/feedback of the correctness of players' pronunciation; and further, to improve players' listening and speaking abilities. The objectives of the study were to conduct a

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preliminary analysis of percentage distribution of the operational behaviors based on learners' long-term operational records during the period of 10 months in the game to understand learners' status of learning, interaction, and playing and to provide relevant discussions as references for future studies.

2 Method

This study analyzed 30 participants' operational records (including 15 males and 15 females) during the period of 10 months. All participants were enrolled members in this game and they were all students in elementary schools or junior high schools in Taiwan. This study categorized the complete log data from a large number of operational interactive records according to the four dimensions below.

- Play: This category includes playing operations in this game, e.g., fighting, or using tools etc.
- Interaction: This category includes player's interaction with other players, e.g., using the chat function and team-forming etc.
- Learning: This category includes the functions especially designed for player's learning in this game, e.g., practicing pronunciation etc.
- Others: Other functions except the three categories mentioned above, e.g., log in and log out etc.

From the classification and generalization, we then preliminarily analyzed learners' learning status in the online game.

3 Results and Discussions

After conducting the analysis based on the classification rules mentioned above, the frequency and proportion distribution of 30 students' operational behaviors during this period was showed as Figure 1. Among this, we can find out that the proportion of students' playing was the highest (54%); the next was learning (e.g., pronouncing practices) (29%), and interaction was about 12 %. These indicated that students' process of learning was accompanied with playing as the main scheme, and also, students could have almost 30% learning behaviors and about 12% peer interaction. Nowadays, game-based learning researches more and more emphasized the importance of situated learning and problem-solving game-based learning approach (e.g. [5]) and the importance of developing problem-solving ability via educational games (e.g. [6]). However, empirical, long-term observation studies for exploring the learning process of this kind of mechanism were rare. The online multiplayer game in this study provided situated problem-solving tasks combining with pronunciation practice based on speech recognition. From the preliminary analytic results, we understood that learners in this game not only had playing and interaction behaviors but also accompanied almost 30% learning behaviors (e.g., practice pronunciation) and had certain peer interaction behaviors. These could explain the feasibility of situated learning context and problem-solving tasks embedded in online multiplayer games to a certain extent.

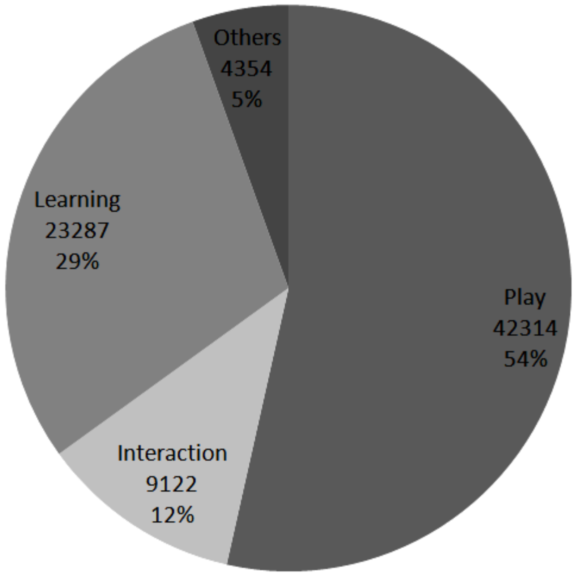

Fig. 1. Frequency and proportion distribution of players' operational behaviors

4 Conclusion

This study observed learners' playing, learning, and interaction in an online multiplayer learning game through a long period of empirical observation. The results indicated that players had learning and peer interaction behaviors to a certain extent. Also, these showed that the online multiplayer games combining with the mechanism of the situated problem-solving tasks had certain potential for the application of educational technology in the future. This study was simply a preliminary exploration focusing on analysis of operation logs. A deep exploration of players' complete learning outcomes, processes, and attitudes are suggested in the future. The results in this study can provide as references for game-based learning researchers or system developers.

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References

1. Alessi, S.M., Trollip, S.R.: Multimedia for Learning: Methods and Development. Allyn and Bacon, MA (2001)
2. Dickey, M.D.: Game Design and Learning: A Conjectural Analysis of How Massively Multiple Online Role-playing Games (MMORPGs) Foster Intrinsic Motivation. Educational Technology Research and Development 55(3), 253–273 (2007)

3. Dickey, M.D.: World of Warcraft and the Impact of Game Culture and Play in an Undergraduate Game Design Course. Computers & Education 56(1), 200–209 (2011)
4. Paraskeva, F., Mysirlaki, S., Papagianni, A.: Multiplayer Online Games as Educational Tools: Facing New Challenges in Learning. Computers and Education 54(2), 498–505 (2010)
5. Ma, Y., Williams, D., Prejean, L., Richard, C.: A Research Agenda for Developing and Implementing Educational Computer Games. British Journal of Educational Technology 38(3), 513–518 (2007)
6. Kiili, K.: Foundation for Problem-based Gaming. British Journal of Educational Technology 38(3), 394–404 (2007)

ACIA—A Course Design Approach to Game Design Theory

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Abstract. Based on constructivist teaching and experiential learning, this research proposes ACIA (stands for Authentic Learning, Learning Community, Interaction, and Assessment) to structure a course of game design theory. Its framework includes: (1) an experiential learning:the college students have to design an educational game for elementary students; (2) a web-based learning community, unlimited to different majors, for inspiring cooperative learning from different stakeholders, as communicating channel for game developers, for obtaining meaningful interaction and guidance fromteachers; and (3) Evaluation, adopting self-assessment, peer and performance assessment to specifically reflect the knowledge, skills, and attitudes in students' learning. A game design theory course with the above three elements can motivate students' active learning and develop their advanced thinking skills.

Keywords: Constructivist Teaching, Authentic Learning, Learning Community, Interaction, Assessment.

1 Introduction

The empirical study of game design mostly emphasizes the design method [1], or educational application of game [2], hardly teaching strategy or method in related courses, especially not the interdisciplinary cooperative learning and user involvement. The game design is distinguished from the software development for it involves experts from different areas, with various professional knowledge, creative, and artistic talents [3], who would consider the game player's interests and needs, and create a user-centered design. Through participatory design, the stakeholders can join the research and co-design the game to ensure the products to meet the needs and usable[4]. For information and design students, game design theory is an entry level course. How do educators construct the course and provide a good training for their students to meet workplace requirements? Theorists of situated cognition advocate that learners interacting with authentic activities and situation under social context, making knowledge meaningful through experience, will be easily transferred to real life situation [5] [6]. Therefore, the authors propose a game design theory course with an approach of ACIA, A representing authentic learning activity, C learning community, I meaningful interaction, and A

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assessment for learning. The framework of ACIA attempts toconstruct a course based on game design production process and combine game players and student designers with different majors through e-learning communities. Students are assigned to design a game for real situation. Their learning attainment will be evaluated by self-, peer, and performance assessment. By action research, the authors will study the feasibility of ACIA and the relationship between the teacher'srole and studentattainment. The major questions include: (1) how to construct a practical situated learning that facilitates theory testing to format learning transfer? (2) How to establish interdisciplinary cooperation by e-learning communities, which advance the exchange of professional knowledge and friendship? (3) How the framework of ACIA to influence the student attainment? (4) In ACIA, how the role of teacher and student to influence student attainment?

2 Reviewed Literature

2.1 Authentic Learning Activities

Authentic learning activitiesare structured in the authentic situation [5]. The educators can well utilize practical activities and meaningful interaction to understand constructivist learning. Provided by the teacher, learners can spontaneously self-express and be self-motivated in real life situation [7]. Kolb's experiential learning theory claims that knowledge is transferred from the experience [8]. With the past and present experiences, through reflection and observation, the learner analyzes the abstract aspects to apply in the next experience. Kolb's experiential learning displays the circulation of four elements: concrete experience, reflection, abstract conceptualization, and active experimentation.

2.2 Learning Community

After market research and play testing by players, entertaining game design often is created to meet players' need. The serious game is more challenging than entertaining game, for creating entertaining experience as well as developing and advancing the assessable skills in practical situation. Introducing the user-centered game design method is necessary [1] [9]. The participatory design further establishes the exchange among stakeholders (users, designers, and promoters) in the process of designing. It plays a key role in functioning [10]. Connolly et al. [11] also discover to employ participatory learning in game design, providing better control of project, better communicating, more satisfactory users and participants, reducing modifying costs, improving feasibility of innovative and creative solutions. Through web-based learning communities, learners can also conduct cooperative projects in anytime and anyplace [12].

2.3 Meaningful Interaction

Many researches display beneficial results from the learning communities, however, which do not guarantee the occurrence of learning. Learning only occurs when the learners decide to value the assigned project and have confidence in their abilities to accomplish it [13]. In the process of cooperation, social interaction is considered the key factor for an individual to achieve optimal cognition, metacognitive regulation and affective involvement [14]. The learners' fundamental sense modes and viewpointsare changed through individual reflection and dialogs with others [15]. Meaningful interaction requires positive relationships, sustained interaction, and community cohesion. In e-learning environment, it is broadly assumed that a trained and experienced online leader (e-moderator) is the key factor of successful cooperative learning [16].

2.4 Assessment for Learning

In information society, it demands that teachers apply the formative assessment to lead students' self learning [17]. Students' formative assessment divides as teachers, students and peers [18]. Teachers' formative assessment requires plenty time of evaluating and useful feedbacks [19].

Self-assessment indicates self-reflection and self-evaluation, occurring in the process of learning. Peer assessment includes learning and evaluation. Students abide certain standards, provide feedback mutually, and evaluate other students' learning quality [20]. Self- and peer assessment move the responsibility of evaluation from teachers to students [21]. Portfolio can be used as self assessment tool, valuable to review students' improvement and maturity, to display learning process and results [22], and to provide learning evaluation, to know mistakes and to re-learn [20].

To summarize the above, this paper proposes ACIA as the framework of the game design theory course (Figure 1).

3 Research Design

3.1 Research Co-participants

15 Information Managementseniors and 23 Digital Content Design juniors participate in this research, lasting one semester, 14 school weeks for seniors and 18 for junior. Divided as groups, each containingsix to eight members, they set the game development goals, plans, and assign individual's tasks. Digital content design majors work on artdesign and information management on programming. It simulates the real workplace situation and establishes positive interdependence to advance learning. The fifth graders are the target game players. The teacher acts as a promoter of instructional designer, techniques advisor, course expert, and so on.

3.2 Course Activities

The learning objective is to develop an educational game, progressing as conceptualization, prototyping, testing and so on. The game themes consist global warming and the fifth grader's math of area calculation. The teacher's task is to supervise, to control the progress, to give related topics, and to establish the learning scaffolding. Students have opportunities to display their results and be responsible for their goals of learning and evaluation. In the end of semester, each group presents their production result and individual performance, andcarries out self- and peer assessment, and summative evaluation.

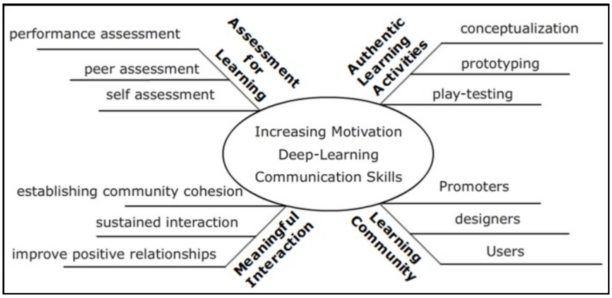

Fig. 1. ACIA Framework

3.3 Data Collecting, Data Coding and Analysis

This research collects data of end semester questionnaires, action letters, digital class discussion forum, group discussion forum, project-related history files, and end semester self- and peer assessment files, ATLAS.ti 5.0 is used to analyze, transfer,

Table 1. Data Coding Examples

Category	Concept	Coding	Examples
Prototyping	AE	L_group_studentnumber_date	Adding on background music freely, a beta version.The file became big with music(L_1_2_052310).
Experiential Learning	CE	C_group_studentnumber_date	Vivid visual picture, special effects, and realistic effects make the game more provoking, for example, Need for Speed (Series); Command and Conquer (Series)(C_3_9_022610).
Self Efficacy	SR	Q_group_studentnumber_date	Regarding the game design, programming is difficult to progress… (Q_4_29_060210).
Peer Assessment	M	P _group_ date	The visual design is good for male players, but shooting game seems distant to environmental education. The text explanation is not attractive (P_5_062410).
Self Assessment	SE	S _group _date	In fact, our project is not complete enough. If we have time, we really want to redraw the visual design (S_5_062410).
Teaching Reflection	LO	A_date	Personal contacts, MSN, cell-phone, to the teacher, are not observable online(A_042210).

Note. AE = Active Experimentation; CE = Concrete Experience; SR = Self Reflection;M = Metacognition;SE = Self-evaluation;LO = Leading online.

and conceptualize collected data word by word, from open coding to spindle decoding and selective coding. Through networking of spindle decoding, it induces research discoveries.

The learning community of 38 studentsconsist five groups, 1 to 5.Each student is assigned a representing number. The coding system is classified by various data sources and given English letter to represent community discussion forum (L), class discussion forum (C), end semester questionnaire (Q), peer assessment (P), self-assessment (S) and action letters (A). Six data sources (category) fromportfolios are analyzed for methodological triangle authentication (Table 1).

4 Discoveries and Discussions

4.1 Studying Sales Object through Authentic Task

Game design theory emphasizes that game design should meet game players' need. In the past, students can design a game freely in game design theory course. They do not realize the principle of "user-centered designing", nor does "let players involve in the development of game designing". To resolve this, this research adopts ACIA. The fifth graders are the target game players. Through e-learning, they can communicate about the format and content and also involve in the project, which allows student designers to experience the "studying the sales object", to understand how unstrained of players' creative thinking intheir hand drawing characters for specific games, thus to inspire designers to study and learn actively.

4.2 E-learning Community Providing Interdisciplinary Cooperative Learning

E-learning community breaks the limitations between institutions and departments. In an interdisciplinary cooperative learning, each student from different field, acting as complimentary role, can contribute one's respective merits to a specific project, not only advancing efficiency, but also learning to appreciate others' contributions, as well as knowing the strength of teamwork. Furthermore, with various educational backgrounds and thinking modes, teamwork challenges each teammate's communication skills. Through teamwork, they can offer communal and emotional support, and then realize the relationship among game designers and true meaning of cooperation.Interdisciplinary cooperation creates unique final production. Digital content design majors understand technology required in game design, and visual animation required complying with logical thinking in programming. Information management majors have to express their need to art designers, explain the key points of incapacity and practical reach, and negotiate to achieve an acceptable consensus.

4.3 ACIA Offering Experiential Learning of Realization of Theory, Abstract Conceptualization—To Display Concrete Evidence of Assessment

Learning by doing is the best way of realizing the true meaning of theory. Under the framework of ACIA, situated authentic task offers the experience of theory and abstract conceptualization. Portfolio reflects student's cognitive development of conceptualization and shows the advancement of techniques and learning attitudes, displaying concrete evidence of assessment. E-portfolios are analyzed in Table 2.

In the knowledge and skills dimension, game design progresses as three stages of conceptualization, prototyping, and play-testing. In conceptualization stage, the tasks divide as data collecting and game planning. In defining tasks, students tend to choose those their abilities can be competent. In prototyping, the tasks divide into design and implementation. In play-testing, difficulty and interface testing are included. In affectiveness dimension, students have learned etiquettes, communication skills,and coordination. Good communication displays understanding and appreciation. Bad communication and departmental selfishness create misunderstanding and distortion. Emotional support is somewhat important. Students' emotional response is related to their expertise and job difficulty; while compatible, they would have the best motivation, positive influences, and profound cognitive involvement. In cognition,they constructed new knowledge through questioning among teammates, concept explaining, and file sharing.

Table 2. Learning Attainment Content Analysis

Dimension	Knowledge & Skills					Affectiveness		Cognition		
Stage	C		P		PT	SI		SK		
Task	DC	GP	D	I	T	IE	CC	Q	CE	SP
Group1	1	30	9	14	4	8	15	5	6	21
Group2	22	32	7	3	1	3	4	1	2	18
Group3	3	29	14	8	0	8	16	8	3	19
Group4	2	12	3	2	0	2	1	1	0	15
Group5	3	44	7	8	1	2	14	5	3	23

Note. C =Conceptualization;P = Prototyping; PT = Play-Testing;SI = Social Interaction; SK = Sharing Knowledge;DC =Data Collecting; GP =Game Planning; D = Design; I = Implementation; T = Testing;IE = Interactive Etiquette; CC = Communication and Coordination; Q = Questions; CE = Concept Explanation; SP = Sharing Portfolios.Numbers represent frequency.

How students perceive tasks influences their attitudes toward the project, such as responsible, self-challenging, or doing only sufficient work. Group 1, in each stage, has great deal of interaction, working best as a team. Group 2 has focused on conceptualization, lacking communication. Group 3has paid more attention on planning, communicating, discussing techniques, losing control of time, and eventually unfinished project with no play-testing. Group 4 has only shared their portfolio, little interaction, low participation, with noskills of negotiating and exchanging no interdisciplinary knowledge and skills, managing minimum works with the prior skills, showing no concrete assessment. Group 5 has fully discussed the plan, responding to every question, proving interaction in authentic task assessment. Their learning displays individual's professional achievement and related ability in teamwork [23], providinginformation to effectively evaluate learningattainment.

In studying of game design portfolios, Kolb's learning cycle has repeatedlyshown (Table 3). Actual development is not so clear cut as Kolb's cycle of four elements. Some team can immediately grasp the idea and execute active experimentation, and then attain new concrete experience. By contrast, someis trapped in the problems, or with no relative responses. The self-reflection happens in different frequency due to different problems encountered. In play-testing, the Kolb's cycle is less likely to happen. The inferred reason is: in post-production, project goals are already set so self-motivated online discussions continue decreasing.

Table 3. Analysis of Experiential Learning Cycle

Conceptualization				Prototyping				Play-testing				Total
CE	RO	AC	AE	CE	RO	AC	AE	CE	RO	AC	AE	
4	2	1	1	1	7	3	14	0	2	0	0	35
5	15	5	29	0	5	1	14	0	0	0	0	74
2	7	0	9	1	11	3	22	0	0	0	0	55
1	4	0	7	0	0	0	11	0	0	0	1	24
5	37	1	13	2	7	2	13	0	1	0	3	84

Note. CE =Concrete Experience; RO = Reflective Observation; AC = Abstract Conceptualization; AE = Active Experimentation. Numbers represent frequency

4.4 Teacher's Self-reflection—Re-learning of Students and Teachers

ACIA is student-centered course, requiring greater active learning. Besides professional knowledge and skills, negotiation and communication are critical in accomplishment. While facing challenging tasks, students make more efforts, meaning greater motivated, greater autonomy. However, with greater motivation, it does not guarantee higher achievement. Achievement standards should also permit proximal development abilities so the goal can be reached. Perceiving self efficacy in assigned tasks, students' achievement is influenced by personal knowledge and skills. In conceptualization stage, with their personal abilities, teammates should express what they can accomplish in time. If their abilities can cope with challenges, complete project in time as expected, and then feel great accomplishments, otherwise great frustration.

In ACIA, the role teacher playing is as a promoter. Interdisciplinary majors rarely understand the difficulty of other professional knowledge and skills. The teacher offers guidance as a coordinator. Besides course knowledge and skills teaching, online guidance, instant scaffolding, negotiation and communication, and control of learning progress are professional knowledge and skills for teachers to attain.

5 Conclusion and Recommendations

Through action research, the teacher continuously self reflects the teaching and learning to understand students' learning attainment under the framework of ACIA. The discoveries include: (1) Authentic tasks oriented, ACIA can advance learning motivation. (2) E-learning community promotes interdisciplinary majors to have cooperative learning. (3) Through authentic tasks, ACIA provides students to apply theory into project, which helps positive learning, specifically reflects students' knowledge, skills, learning attitudes, and assessment. (4) Cooperative learning can train students' social communication skills, high-level thinking, and interdisciplinary skills and have responsible attitudes towards learning. (5) While adopting ACIA, additionally, the teacher has to possess online guiding skills, provide appropriate scaffolding in course, organizing schedule, and set standards of peer-assessment and self-assessment.

Several recommendations are provided for future research: (1) in related courses, the authentic tasks are not limited to educational game design. Lacking education theoretical concepts might lead to irrelevant topics and useless results. The implementation tool for authentic task may consider simpler tool kits; instead of difficult programming, configuring interaction in game design can decrease difficulty and promote positive learning. (2) The training of communication and negotiation should consider the form ofcommunication, timing, perceptional gaps, and learning attitude. The teacher should arrange face to face discussion time, increasesynchronized learning platform, provide multi-channel communication, well integrate computer media conference in online course, and accompany themwith positive learning experience [24]. (3) The teacher should work as action researcher, adjusting teaching manner constantly, not always usingsingle textbook, continuously providing sufficient materials,and responding to different questions.(4) Prepare students to adjust their learning attitudes, cultivate their active learning ability, and nurture their information literacy, and interdisciplinary knowledge and skills.

References

1. Charles, D., Kerr, A., McNeill, M., McAlister, M., Black, M., Kcklich, J., et al.: Player-Centered Game Design: Player Modeling and Adaptive Digital Games. In: DiGRA 2005 Conference Changing Views–Worlds in Play, vol. 285, pp. 285–298 (2005)
2. Van Eck, R.: Digital Game-based Learning: It's not just the Digital Natives who are Restless. Educause Review 41(2), 16 (2006)
3. Tschang, F.T., Szczypula, J.: Idea Creation, Constructivism and Evolution as Key Characteristics in the Videogame Artifact Design Process. European Management Journal 24(4), 270–287 (2006)
4. Spinuzzi, C.: The Methodology of Participatory Design. Technical Communication 52(2), 163–174 (2005)
5. Brown, J.S., Collins, A., Duguid, P.: Situated Cognition and the Culture of Learning. Educational Researcher 18(1), 32–42 (1989)
6. De Vries, E.: Students' Construction of External Representations in Design-based Learning Situations. Learning and Instruction 16(3), 213–227 (2006)
7. Dewey, J.: Experience and Education: The 60th Anniversary Edition. Kappa Delta Pi, West Lafayette, IN (1998)
8. Kolb, D.: Experimental Learning. Prentice-Hall, Englewood Cliffs (1984)
9. Pagulayan, R.J., Keeker, K., Wixon, D., Romero, R.L., Fuller, T.: User-centered Design in Games. The Human-computer Interaction Handbook: Fundamentals, Evolving Technologies and Emerging Applications. Lawrence Erlbaum Associates, Inc., Mahwah (2002)
10. Miller, R.A., Luse, D.W.: Advancing the Curricula: The Identification of Important Communication Skills Needed by IS Staff During Systems Development. Journal of Information Technology Education 3, 117–131 (2004)

11. Connolly, T.M., Stansfield, M., Hainey, T.: An Application of Games Based Learning within Software Engineering. British Journal of Educational Technology 38(3), 416–428 (2007)
12. Lazonder, A.W., Wilhelm, P., Ootes, S.A.W.: Using Sentence Openers to Foster Student Interaction in Computer-mediated Learning Environments. Computers and Education 41, 291–308 (2003)
13. Paraskeva, F., Mysirlaki, S., Papagianni, A.: Multiplayer Online Games as Educational Tools: Facing New Challenges in Learning. Computers & Education 54(2), 498–505 (2010)
14. Vygotsky, L.S.: Mind in Society: The Development of Higher Psychological Processes. Harvard University, Cambridge (1978)
15. Driver, R., Asoko, H., Leach, J., Mortimer, E., Scott, P.: Constructing Scientific Knowledge in the Classroom. Educational Researcher 23(7), 5–12 (1994)
16. McPherson, M., Nunes, J.: Critical Issues for E Learning Delivery: What Seem Obvious is not always Put into Practice. Journal of Computer Assisted Learning 24(5), 433–445 (2008)
17. OECD.: Formative Assessment: Improving Learning in Secondary Classrooms. OECD, Paris (2005)
18. Ozogul, G., Sullivan, H.: Student Performance and Attitudes under Formative Evaluation by Teacher, Self and Peer Evaluators. Educational Technology Research and Development 57(3), 393–410 (2009)
19. Olina, Z., Sullivan, H.: Effects of Classroom Evaluation Strategies on Student Achievement and Attitudes. Educational Technology Research and Development 50(3), 61–75 (2002)
20. Van den Berg, I., Admiraal, W., Pilot, A.: Design Principles and Outcomes of Peer Assessment in Higher Education. Studies in Higher Education 31(3), 341–356 (2006)
21. Orsmond, P., Merry, S., Reiling, K.: A Study in Self-Assessment: Tutor and Students. Assessment & Evaluation in Higher Education 22(4), 357–369 (1997)
22. Chang, C.-C.: Enhancing Self-perceived Effects Using Web-based Portfolio Assessment. Computers in Human Behavior 24(4), 1753–1771 (2008)
23. Mason, R., Pegler, C., Weller, M.: E Portfolios: An Assessment Tool for Online Courses. British Journal of Educational Technology 35(6), 717–727 (2004)
24. Goodyear, P., Jones, C., Asensio, M., Hodgson, V., Steeples, C.: Networked Learning in Higher Education: Students' Expectations and Experiences. Higher Education 50(3), 473–508 (2005)

An Application of Interactive Game for Facial Expression of the Autisms

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Abstract. According to Diagnostic and statistical manual of mental disorders (DSM-IV-TR), the lack of social behavior is a standard diagnosis of Autism Spectrum Disorder (ASD). The aim of the paper is to develop a game-based learning approach to improve the ASD children's ability to express facial emotion and communicate with others in social activities. Therefore, the interactive game, FaceFlower, is developed and evaluated. The qualitative analysis of the experts' evaluation yields that the interactive game is effective for the ASD children. Besides, it provides some suggestions: (1) A tutorial could be established to help players understanding the game rules and avoid them being confused. (2) Players could choose the background music, the themes and colors of the game background when playing the game. (3) The excessive elements in the game might cause ASD children unfocused and bring pressure to them.

Keywords: Autistic, facial expression, facial recognition, emotion, interactive game.

1 Introduction

People with Autism Spectrum Disorder (ASD) have some characteristics such as lack of good social communication, repetitive and restricted behaviors. ASD children could be outstanding at memorizing lists, maps, and other spatial or temporal patterns. However, most of them have difficulty in recognizing facial emotion. They can't understand other people's feeling and emotional feedback; they lack emotional intelligence, especially empathy and a suitable response in an emotional situation (Picard, 2000). Computer games could provide an suitable approach for ASD children's learning. For example, the computer games could simulate social scenarios and repeat the learning activity. Therefore, the game-based learning on a computer could help the ASD children learn facial expression and social communication.

In this project, the interactive game, named "FaceFlower", is developed for the ASD children. The purpose is to improve their facial expression and social communicate skill with peers. Utilizing their facial expression as an affective interface of the game, players can interact with the game system in a natural way.

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2 Literature Review

2.1 Social Difficulties in Autism Spectrum Disorder (ASD)

Autism Spectrum Disorder (ASD) is a lifelong developmental disability, which affects 1 in 110 people and costs more than $3.2 million in care during an individual's lifetime due to their special needs (Autism Connections, 2011). People with ASD usually have three domain difficulties. The first difficulty is having less social relationship with others. Some individuals with ASD are usually very isolated from others. The second one is communication problem. Some individuals with ASD have difficulty in gaining verbal (e.g. speech) or non-verbal (e.g. gesturing; facial expression) communication. The third one is they tend toward repetitive and restricted behaviors. Some individuals with ASD may prefer a rigid or routine way of living and will avoid new activities.

Most of the ASD people have some sort of communication impairment, especial for non-verbal communication. Non-verbal communication is usually understood as the process of sending and receiving wordless messages. The wordless messages such as emotional or social messages could be transmitted through gesture; body language or posture; facial expression and eye contact. However, children with ASD have impairment in the use of multiple nonverbal behaviors, such as eye-to-eye gaze, facial expression, body posture, and gestures.

2.2 Innovative Technology for People with Autism Spectrum Disorder

Interactive technology may be used to promote interventions specifically designed for ASD. Some is to solve their difficulty in recognizing facial expressions and emotion. For example, DVD-based programs and educational computer games are being developed to teach how to look at faces and identify emotions (Transporters; Face Say; FaceLand; Let's Face it). Robots and dolls that can track faces, expressions, and direction of eye-gaze are being designed to teach basic social interaction skills, such as turn-taking and imitation, in a way that is more engaging and less stressful for individuals with ASD than face-to-face human interaction (The AuRoRA Project; Other Social Robots http://bit.ly/bNy3uh) (Autism Connections, 2011). Besides, the Robbie the Robot game helps the ASD children to recognize emotions. The game aims at helping ASD children to identify other's facial emotion in a non-confrontational environment that they enjoy.

Though there are many digital products such as on-line game, computer games, it is rare that the ASD children could practically use their facial muscle to express their emotion while they play computer games. Using the technology of interactive design and emotion recognition to design affective interface of the game could enhance immediateness and physical interaction of the game.

3 Project: FaceFlower

This project is an interactive game which aims at addressing the ASD children's social difficulties. It helps ASD children to learn the emotional messages of one's facial expression and advance their social communication skill when they play the game with others.

3.1 Design Concept

The interactive game, named "FaceFlower", provides a game-based learning approach to help ASD children to improve their two difficulties: the non-verbal communication and the social relationship. FaceFlower is installed in a personal computer with a webcam. In order to create a pleasure and nature atmosphere, FaceFlower adopted the ecological learning content which includes two units. The first unit is the process of the plant growth. It is used to train ASD children's to express their facial emotion and recognize other's. The second unit is a natural and ecological environment. It is used to train ASD children to communicate with others in the social activity.

FaceFlower creates a game-based learning approach to the facial expression and the cooperation with the peers for the ASD children. Players' facial emotion expression is the affective interface of the interactive game. They have to use their facial expression to control the game. By the game-based approach, ASD children could practice their facial gesture and muscles; moreover, they could recognize and apply facial expression without pressure. Furthermore, they could learn to recognize others' facial expression and appropriately reply others. The easy and rich game help ASD children voluntarily interact with others in the playful atmosphere.

3.2 System Design

The flow chart of FaceFlower is shown as Fig. 1. The facial emotion category of this project is based on the facial action coding system (FACS) developed by Ekman (Ekman & Friesen, 1978). When FaceFlower begins, players' expression is recognized by eMotion software. Then, the game will show corresponding feedbacks.

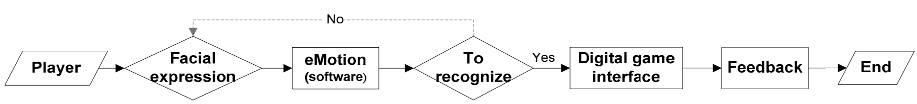

Fig. 1. The Flow Chart of FaceFlower

3.3 Facial Emotion Computing

eMotion, a facial emotion recognition software, is employed in the interactive game. eMotion developed by the ISLA Laboratory at the Universiteit van Amsterdam is constructed by a face tracking algorithm. eMotion handles the following process in this interactive game: (1) Face tracking: one's face captured by the webcam is tracked and detected; (2) Feature extraction: the moving vectors of motion units (MUs) on one's face are extracted and computed; (3) Facial expression classification: the moving vectors were classified to into seven categories (neutral, happy, surprise, angry, disgust, fear, sad), according to the facial emotion defined by FACS (Sebe et al., 2006). A screen shot of the face tracking and the emotion recognition by eMotion software is shown in Fig. 2.

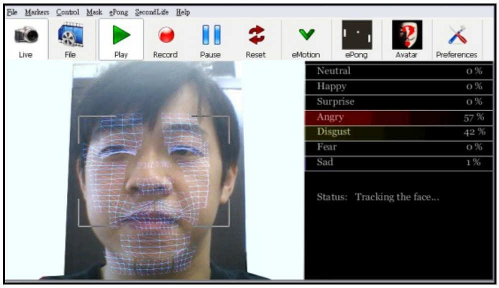

Fig. 2. A screen shot of eMotion. The left: one's face overlayed the wireframe is tracked. The right: the result of one's facial emotion is identified.

In order to clarify players' emotion tendency, the result of a player's facial emotion recognition was computed by equation 1. Thus, players' emotion tendency was classified to positive and negative. Moreover, the result of a player's facial emotion recognition was computed by equation 2. Players' emotion level is divided to low (±10~±24%), middle (low±25~±49%) and high (±50~±100%). The visual feedback of the interactive game could vary with players' emotion level.

$$\text{Emotion Tendency} = \text{happy} + \text{surprise} - 0.25\text{disgust} - 0.5\text{fear} - \text{angry} - 0.25\text{sad}\ . \qquad (1)$$

$$\text{Emotion Level } (\%) = [(\text{happy} + \text{surprise}) - (\text{sad} + \text{fear} + \text{disgust} + \text{angry})] + \text{neutral}. \qquad (2)$$

The hardwares of FaceFlower consist of a PC, a LCD display and a webcam. The webcam is mounted on top of the LCD screen. Players are asked to stand in front of the webcam (focused on the face area) which is used to capture player's facial features.

3.4 Implementation

FaceFlower is an interactive game for facial expression. It includes two units as follows:

The First Unit: Facial Emotion Expressing

The screen of the first unit is a garden scene. ASD children are invited to help the flower grow up in the limited time. The random expressive pictographic below the screen is used to instruct players to control their facial expression. The process of the flowers growth responds to players' facial emotion simultaneously. The basic factors for flowers blooming are sun and rain Thus, it is designed that a player's positive facial expression induces the glowing sun; his (her) negative facial expression elicits the raining. If the ASD child's facial emotion as the same as the expressive pictographic, the flower will keep growing. Otherwise, the flower would wither away. The game interface of facial emotion is shown as Fig. 3.

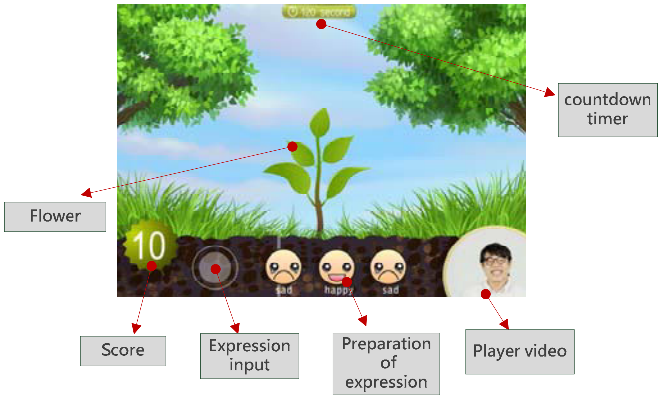

Fig. 3. The game interface of "facial emotion expressing"

The Second Unit: Social Interaction with Peers

THE second unit of the game includes some peer activities. The ASD child has to complete gardening construction with peers in the limited time. During the process of the game, the ASD child needs to control his (her) facial expression and observe others' facial expression. Besides, the ASD child uses their facial expression, body movement, and attention to communicate with other players. Meanwhile, other players' behavior provides the ASD child assistance and demonstration.

When two players' facial expressions are the same as the expressive pictographic in the middle of the flower, the sun or rain appears to grow the flower. The season is changing in order to intrigue players' interests. Thus, the ASD children could establish their social relationship with other peers after playing the interactive game. Furthermore, they could learn to recognize other's facial emotion and reply others appropriately. The game interface of social interaction with other peers is shown as Fig. 4.

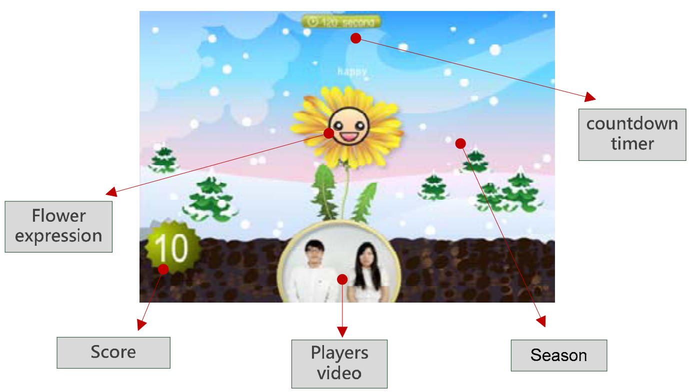

Fig. 4. The game interface of social "interaction with peers"

4 Evaluation

4.1 Method

The expert heuristic method was applied to evaluate the interactive game, FaceFlower. The concept and video record of FaceFlower were published to the Autism Connections of Core77 on-line showcase platform which collects the designs for the autism. The educator and designers from international countries discuss and command on this website platform. We invited one researcher and six design students from the United States in the field of the autistic education and design. The experts' information is as Table 1. They give comments and evaluations towards our demonstrative video published on the online platform. The evaluation time is a week. Experts' evaluation description was analyzed by qualitative analysis method.

Table 1. Expert's information

Expert	*Experts*	*Expertise*
Expert4	Researchers	Professionals and technology experts in the field of autism education.
Expert1,2,3,5,6,7	College students& graduate students	Design experts in the following fields: industrial design, multimedia design and commercial design.

4.2 Qualitative Analysis

The Table 2 summaries are the seven experts' evaluation for FaceFlower.

We have acquired seven valid advices from the experts' evaluation. The qualitative data of the experts' evaluation were processed three steps: the open coding, axial coding and core categories as Table 3. Each core category is composed of few axial coding. The core categories yield the following results: (1) A tutorial could be established to help players understanding the game rules and avoid them being confused. (2) Players could choose the background music, the themes and colors of the game background when playing the game. (3) The excessive elements in the game might cause ASD children unfocused and bring pressure to them. (4) FaceFlower could be packed to commercialize.

Table 2. The seven experts' evaluation

No.	Evaluation
Expert 1	I am not sure if these metaphors are right. If children get used to this game, one rainy day they might get frustrated because the weather doesn't change according to their facial expression or their mood. This might mislead them. ASD children are very sensitive to music. Thus, it would be great if they could choose from several music options which they like.

Table 2. (*Continued*)

Expert 2	The music choice is very subjective, so a variety of choices would be nice to ASD children. Another option should be no music at all. As I know, many ASD individuals cannot have multitask so it might be very difficult for them to listen to the music, watch the movement of the happy/sad pictures, and make a facial expression all at the same time. They can become extremely frustrated if they can't keep up with the flow of the game since there are a few things going on the screen. For future developments, you might provide a variety of themes of the game. For example, the user could choose the theme of the game to play, before the game starts. The garden theme is nice, but it might not appeal to a wide variety of kids. If the kids were boys, maybe they would prefer playing the game with a different theme (not flowery).
Expert 3	…my only question is: Could some ASD children be stressed by the countdown of 3 minutes (or less) to make the right facial expression?
Expert 4	It is a good project but the scope of the project is a bit limited. It could be sold on the internet to parents or therapists. I would seriously invite you to find a developer or propose it on Apple Store if you want to bank on this project.
Expert 5	I like the training approach that kids use facial expressions as the game controller. However, I worry that the metaphors of the excessive element could be misleading to them. Perhaps you could provide a tutorial to avoid players being confused? Besides, I suggest providing players more than one theme / background color.
Expert 6	Have you considered adding other types of instruction instead of pictures, such as happy verbal or clapping sounds for "happy" emotion? And for "sad", it could be a soft verbal sound.
Expert 7	It might be a little hard to the ASD children, unless it provides a tutorial to interpret how to play and collaborate with other players. Simpler it is, more helpful it might be for the child.

Table 3. Axial coding of the experts' advice

Core category	Axial coding	Open Coding
Emotional Senses	Visual	Theme / background color variety. Teaching guide. Excessive element. Blurred focus.
	Hearing	Background music variety. None music.
Future Work	Commercialize	Web Service, mobile, App Store.

5 Conclusion

FaceFlower is an interactive game for ASD children to learn facial expression. It aims at training ASD children to identify facial emotion and improving social skills with peers. The evaluation yields some results and suggestions. It is highly recommended that the proper tutorials should be provided to the players before the game starts. It might bring players more pleasure that to provide players more options of the background music, colors and themes. Besides, too many visual elements on the screen might cause the ASD child unnecessary anxieties and pressures.

FaceFlower apply players' facial expression as the affective interface of the game. It could be used to improve two ASD's obstacles, non-verbal communication and social behavior. It could be the educative assistant for the parents or therapists. In other word, the game-based therapy might provide some innovative idea to the game industry in the future.

References

1. Ekman, P., Friesen, W.V.: Manual for the Facial Action Coding System. Consulting Psychologists Press, Palo Alto (1978)
2. Lankes, M., Riegler, S., Weiss, A.: Facial Expressions as Game Input with Different Emotional Feedback Conditions. Paper Presented at the The Conference of Advances in Computer Entertainment Technology (2008)
3. Madsen, M., Kaliouby, R., Goodwin, M., Picard, R.: Technology for Just-In-Time In-Situ Learning of Facial Affect for Persons Diagnosed with an Autism Spectrum Disorder. Paper Presented at the The Conference of the 10th International ACM SIGACCESS Conference on Computers and Accessibility (2008)
4. Picard, R.W.: Affective Computing. MIT Press, Massachusetts (2000)
5. Pioggia, G., Sica, M.L., Ferro, M., Casalini, S., Igliozzi, R., Uratori, F.: Facial Automaton for Conveying Emotions as a Social Rehabilitation Tool for People with Autism. Itech Education and Publishing, Vienna (2007)
6. Sebe, N., Lew, M.S., Sun, Y., Cohen, I., Gevers, T., Huang., T.S.: Authentic facial expression analysis. The Journal of Image and Vision Computing 25, 1856–1863 (2006)
7. Wang, C.-M.: The Effects of Multimedia Computer Assisted Instruction on the Coin Use Skills for Elementary School Students with Mild Autism. National Taichung University of Education, Taichung City (2009)
8. Ye, j.-j.: Develop the System of Virtual Learning Environment and apply to Social Interaction for People with Autistic Spectrum Disorder. National Changhua University of Education, Changhua County (2008)
9. Autistic Games, `http://www.autismgames.com.au`
10. i autistic. Freeautism games & tutorials, `http://iautistic.com/chinese/free-autism-games.php`
11. Autism Connections, Core77, `http://challenges.core77.com/contests/autism-connects/landing/`

A Cloud and Agent Based Architecture Design for an Educational Mobile SNS Game

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Abstract. Combining mobile SNS concept and intelligent cloud technology, we propose a cloud and agent based architecture design, for a specific educational mobile SNS game. Our approach is inspired from learning and memory theory of cognitive psychology. We designed a mobile educational SNS game based on cloud architecture, including game logic and conceptual design, the architecture of a common mobile game engine and architecture of intelligent cloud platform. This game can link player and his/her friends via a living virtual agent world, not only for fun, the intelligent cloud server also can provide services for life, education, research, work and communication, etc.

Keywords: cloud, agent, mobile SNS game.

1 Introduction

1.1 Background

In 2010, SNS game became more and more popular all over the world, most of them are based on web, mobile, or cloud techonlogies. On the social-networking website Facebook, the most popular application FarmVille, has over 62 million active users and over 24.6 million Facebook application fans as of September 2010, about 10-15 percent of all Facebook users play it! In the biggest online game marketplace China, a game named Happy Farm (or called toucai game) attracts more than 100 million daily active users. In this kind of SNS game, people may spend countless hours playing online, they may even spend excessive amounts of money to purchase additional seeds and guard dogs, but when all is said and done, the true attraction of the farm obsession is not the virtual world farming, but the real world interpersonal connections.

Today, the 3G/3.5G/4G and Wi-Fi technologies allows in most cases online multiplayer gaming on cellphone. The SNS mobile games exist where players use their cellphones to access a community website where they can play browser-based games with thousands of players. In the past, such games typically have limited graphical content so that they can run on a cellphone, and the games focus on the interaction between a large number of participants. Nevertheless, with the emergence of iPhone, iPad and Android devices, this situation is changing totally. In addition, the new business model of App Store and the similar services for mobile devices also brought

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undergone enormous changes to mobile gaming market. Until now, there are more than 300,000 third-party applications officially available on the Apple's App Store, with over 7 billion total downloads.

SNS, Mobile, Agent and Cloud Computing, these emerging technologies drive us to think of a new educational game mode: Mobile SNS Game based on Intelligent Cloud. Mobile technologies bring us a lot of conveniences for life. Cloud technologies let us enjoy services at anywhere, anytime. Agent technology provides intelligent ability to the cloud, and SNS services bring us a lot of funs and interactions with our families and friends. Integrating these technologies, we believe there must be a huge potential research and market value in this direction.

1.2 State of the Field

Cloud computing represents a distributing computing mechanism that by the utilize of the high speed network, data processing is moved from private PC or servers to the remote computer clusters (big data centers owned by the cloud service providers), any user has a potential super computer at hand and can access the data and get the computing capability at any time, from anywhere, user only need to pay for the resources which have been used, don't care about who provide the resources and in what way. Cloud computing systems fundamentally provide access to large pools of data and computational resources through a variety of interfaces similar in spirit to existing grid and HPC resource management and programming systems [1].

Mobile Cloud Computing is widely accepted as a concept that can significantly improve the user experience when accessing mobile services. By removing the limitations of mobile devices with respect to storage and computing capabilities and providing a new level of security by a centralized maintenance of security-critical software for e.g. mobile payment applications, it is expected that it will find broad acceptance on the business as well as consumer side [2].

Agent technology is the one of the most recent contributions to the field of Computer Science and Engineering. It has several benefits compared to existing development approaches, in particular the ability to let agents represent high-level abstractions of active entities in a software system. An agent is an encapsulated computer system that is situated in some environment, and that is capable of flexible, autonomous action in that environment in order to meet its design objectives [3]. In a common environment, there might be many co-existing agents which can interact with each other, these interactions can vary from simple information exchanges, to requests for particular actions to be performed and on to cooperation, coordination and negotiation in order to arrange inter-dependent activities. [11] [12].

As we know, the computational world is becoming very large and complex. Cloud Computing has emerged as a popular computing model to support processing large volumetric data using clusters of commodity computers. The evolution of cloud computing can handle such massive data as per on demand service. Nowadays the computational world is opting for pay-for-use models and Hype and discussion aside, there remains no concrete definition of cloud computing. Cloud Computing is evolving as a key computing platform for sharing resources that include infrastructures, software, applications, and business processes.

As for the architecture of cloud computing, Bhaskar, Eunmi and Ian first develop a comprehensive taxonomy for describing cloud computing architecture [4]. They use this taxonomy to survey several existing cloud computing services developed by various projects world-wide such as Google, force.com, Amazon. They use the taxonomy and survey results not only to identify similarities and differences of the architectural approaches of cloud computing, but also to identify areas requiring further research. Zhang and Zhou have proposed the Cloud Computing Open Architecture (CCOA) based on seven architectural principles and ten architectural modules, by integrating the power of service-oriented architecture (SOA) and virtualization technology of hardware and software [5].

As for the intelligent mobile computing architecture, in 2009 Pike, Ehlers and Oosthuizen proposed an approach to enhancing mobile agent protection. Mobile agents may come under threat from malicious hosts and unscrupulous agents [6]. In an effort to reduce risk for mobile agents and improve the robustness of mobile agent systems - the proposed trust-based approach could be used to augment existing mechanisms aimed at mobile agent protection. Haddar, Kacem, Metivier, Mosbah, and Jmaiel proposed a novel formalized mobile agent distributed computation model based on transition systems is presented [7]. In their model, the mobile agent actions (e.g. computations, communication and migration) are described using transitions. Thus, a mobile agent algorithm is viewed as a transition system and the underlying distributed system is modeled by a connected graph. They exploit the high-level encoding of agent actions by transitions to prove the correctness of agent algorithms. Phyoung Jung Kim and Young Ju Noh proposed an architecture of mobile agent system [8]. To evaluate the performance of the proposed architecture in a mobile computing environment, they implemented a cyber-market called mobile market agent service (MMAS). In applying their proposed architecture to the MMAS, they found that the mobile agent technique could be suited for the mobile application through the implementation of MMAS, and found out that the proposed architecture could solve the mobile vulnerabilities caused by a mobile computing environment.

As for the combination research of cloud computing, mobile computing and Agent, Foster, Jennings and Kesselman start the research work from 2004 [9]. And in 2009, Zehua Zhang and Xuejie Zhang proposal the MABOCCF (Mobile Agent Based Open Cloud Computing Federation) mechanism [10], it combines the advantages of Mobile Agent and cloud computing to provide a realization for the Open Cloud Computing Federation, MABOCCF can span over multiple heterogeneous Cloud Computing platforms and realizes portability and interoperability, it can be a beginning of open cloud computing federation and a future part of cloud computing.

2 Our Design and Approach

The inspiration of our game comes from learning & memory theory about human's brain. In cognitive psychology, memory is usually divided into three storage systems: sensory, short-term, and long-term. The processing of information through these storage systems is often referred to as the model of figure 1.

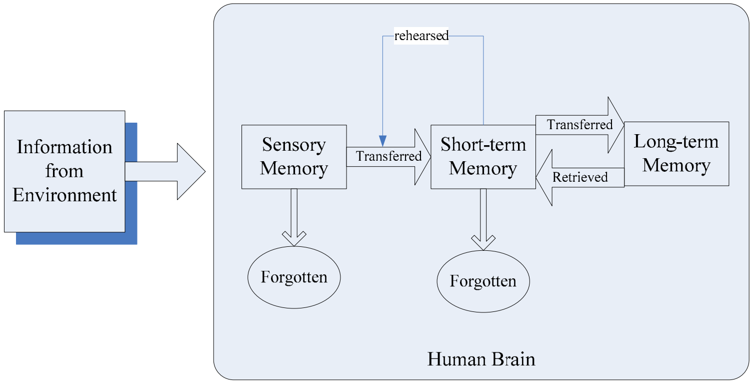

Fig. 1. Information processing model

Everyone might often meet this situation: when one try to remember something, some information or some specific knowledge, one can not retrieve it because of forgotten long time ago and the limited capacity of memory. So we want design an agent living in the mobile game can help people to keep some things or knowledge in a virtual cloud. For example, when player want to go to a new place to travel, the agent will help player to gather travel information; or when player want to buy a new laptop or camera, the agent will surf Internet and report some suggestions to player. All this will be done automatically in cloud server when player might be sleeping or working. This game can be an intelligent companionship to help people for life, education, communication and work etc., and to make up human's physiological limitation.

Here lists some conceptual ideas and designed features, and game logic of this game as a case study.

- Game Name: I'M Agent.
- Slogan: I'm Agent, your assistant.
- Conceptual Ideas: in the game world,

  - Agents live in a city (mapping real city in the world, such as Beijing, Shanghai, Singapore, etc.) selected by player, one agent will represent one player living in a village of the city, commonly the agents living in a same village are friends (same as the relationship between players in the real world), agent can earn prizes (virtual money) by representing his master to attend knowledge competition in specific area hosted in game world regularly or irregularly.
  - At beginning, agent has no knowledge, every player have to spend some time to train his/her agent by teaching the answers for a quiz of some specific area, such as city travel information, cooking, language, etc., which is called **Learning by Teaching**. In the first version, prior game world knowledge library will be built in the game world by game masters; later with the launching online, more and more registered users will contribute their

knowledge for the world, just like the mode of web 2.0 or wiki site. Theoretically, with the mobile/cloud architecture, the knowledge area can be expanded infinitely in cloud side. The information learned from this mode will be transferred to knowledge storing into **Long-Term Memory**.

- Agent can also study by self, the player can command his/her agent stay in house to surf internet and study information about specific area or discipline, which is called **Learning by Reading**. The information learned from this method will be stored into **Short-Term Memory** and can be forgotten in some forgetting rate. After studying, player can see and judge if the information is useful. Useful information will be transferred to knowledge storing into **Long-Term Memory**.
- Agents also can walk around in village freely, or spend some virtual money to travel to other places, during this walking or travelling process, they can randomly meet other agents to exchange information, which is called **Learning by Doing**. If the player specifies the goal of this travel in advance, the information learned from this method will be stored into **Short-Term Memory**. Same with learning by reading, the player can see and judge if the information is useful and store useful information into **Long-Term Memory**. Otherwise, if the walk is taken by agent self, the collected information will be stored into **Sensory Memory** with higher forgetting rate. The player can ask agent to retell/replay the travel process and decide if the information in sensory memory should be transferred. Here are two game concept designs to demonstrate.

Fig. 2. Conceptual design about Learning by Doing

Left: the event list of one agent

Right: the agent is travelling to another city and meets other agent

- Sensory Memory and Short-Term Memory have their different forgetting rate, with time passing, some information stored in this two memories will be forgotten unless the player ask to transfer them into knowledge and to store into Long-Term Memory, or the agent can spontaneously read the same information from Internet or listen it from other agent in specific number of times (called repetition rate) during the process of Learning by Doing.
- To add fun and to add some research value for the game, during the process of Learning by Reading, the agent also can go to sleep and have a dream at some time. Dream will start randomly from one object/concept/agent that is learned or met recently to other object/concept/agent one by one along knowledge networking in memory system. During the **Dreaming Period**, the player can view the agent's activity in the dream. The random accident factors will let the game seem ridiculous and interesting.
- In the cloud system, knowledge's structure and storage are very important. Our design will refer to Object-Oriented thinking, Tagging method, Self-Organizing Map, Concept Map etc. Ideas will imitate and refer to the structure and process of human's brain and memory system. We believe that will increase a natural, mystery and magical power to this game, as well as the value of research.

In our design, the mobile phone is just a window connecting the player in the physical world and agent living in cloud virtual world. This architecture will make sure that our game has unlimited flexibility and expandability. Figure 3 shows our design of mobile game engine and figure 4 shows the overview of system architecture in the cloud side.

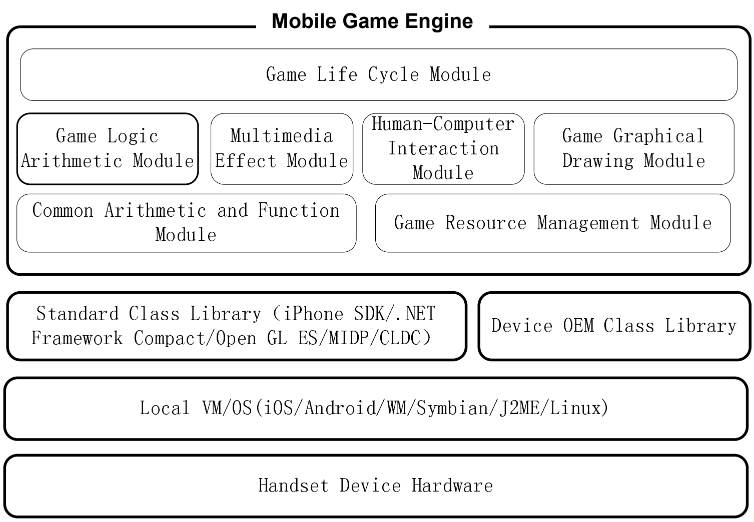

Fig. 3. Architecture of our common mobile game engine

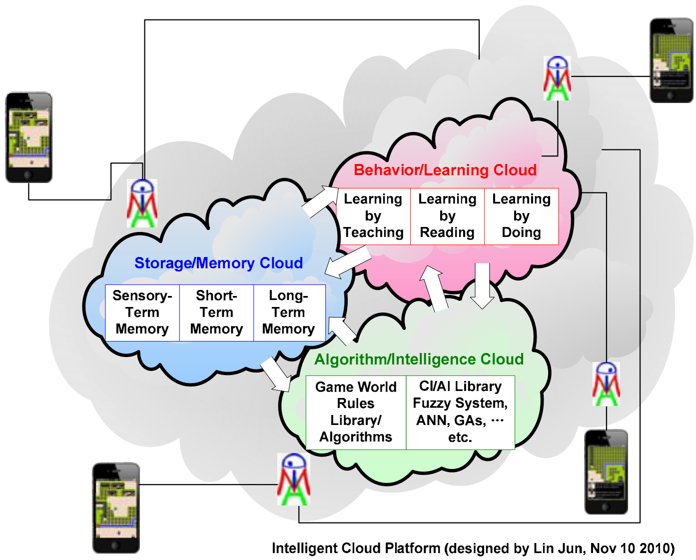

Fig. 4. Architecture of our intelligent cloud platform

Additionally in the server side, we will utilize some emerging CI/AI approaches including Fuzzy System, Artificial Neural Networks, Genetic Algorithm, Evolutionary algorithms etc. into the Intelligent Cloud Platform, which can be used to mine, identify, classify and cluster the key elements of the objects in the virtual game world.

3 Conclusion

The mobile SNS game based on intelligent cloud can link player and his/her friends via a living virtual agent world, not only for fun, in the future, the intelligent cloud server also can provide services for life, education, work and communication, etc. With the mobile and cloud platform architecture and intelligent agent/multi-agent related technologies, the game can provide more and more interesting and useful functions for real life in the future, also user can join into the process of creativity.

References

1. Klein, A., Mannweiler, C., Schneider, J., Schotten, H.D.: Access Schemes for Mobile Cloud Computing. In: Proceedings of the 2010 Eleventh International Conference on Mobile Data Management, pp. 387–392 (2010)
2. Jennings, N.R.: Agent-Oriented Software Engineering. In: Garijo, F.J., Boman, M. (eds.) MAAMAW 1999. LNCS, vol. 1647, pp. 1–7. Springer, Heidelberg (1999)

3. Nurmi, D., Wolski, R., Grzegorczyk, C., Obertelli, G., Soman, S., Youseff, L., Zagorodnov, D.: The Eucalyptus Open-Source Cloud-Computing System. In: Proceedings of it the 2009 9th IEEE/ACM International Symposium on Cluster Computing and the Grid, pp. 124–131 (2009)
4. Rimal, B.P., Choi, E., Lumb, I.: A Taxonomy and Survey of Cloud Computing Systems. In: Proceedings of the 2009 Fifth International Joint Conference on INC, IMS and IDC (NCM 2009), pp. 44–51. IEEE Computer Society, Washington, DC, USA (2009)
5. Zhang, L.-J., Zhou, Q.: CCOA: Cloud Computing Open Architecture. In: Proceedings of the 2009 IEEE International Conference on Web Services (ICWS 2009), pp. 607–616. IEEE Computer Society, Washington, DC, USA (2009)
6. Pike, J.R., Ehlers, E.M., Oosthuizen, O.L.: A Specialised Architecture for Embedding Trust Evaluation Capabilities in Intelligent Mobile Agents. In: Ghose, A., Governatori, G., Sadananda, R. (eds.) PRIMA 2007. LNCS, vol. 5044, pp. 404–409. Springer, Heidelberg (2009)
7. Haddar, M.A., Hadj Kacem, A., Métivier, Y., Mosbah, M., Jmaiel, M.: A Distributed Computational Model for Mobile Agents. In: Ghose, A., Governatori, G., Sadananda, R. (eds.) PRIMA 2007. LNCS, vol. 5044, pp. 416–421. Springer, Heidelberg (2009)
8. Kim, P.J., Noh, Y.J.: Mobile agent system architecture for supporting mobile market application service in mobile computing environment. In: Proceedings of 2003 International Conference on Geometric Modeling and Graphics, pp. 149–153 (2003)
9. Foster, I., Jennings, N.R., Kesselman, C.: Brain meets brawn:why grid and agents need each other. In: Proceedings of the Third International Joint Conference on Autonomous Agents and Multiagent Systems, AAMAS 2004, pp. 8–15 (2004)
10. Zhang, Z., Zhang, X.: Realization of Open Cloud Computing Federation Based on Mobile Agent. In: IEEE International Conference on Intelligent Computing and Intelligent Systems, pp. 642–646 (2009)
11. Leong, P., Miao, C., Lee, B.-S.: A survey of agent-oriented software engineering for service-oriented computing. International Journal of Web Engineering and Technology 4(3), 367–385 (2008)
12. Ashoori, M., Miao, C., Cai, Y.: Socializing Pedagogical Agents for Personalization in Virtual Learning Environments. In: Proceedings of the 2007 IEEE/WIC/ACM International Conferences on Web Intelligence and Intelligent Agent Technology - Workshops, pp. 346–349 (2007)
13. Poole, D., Mackworth, A., Goebel, R.: Computational Intelligence: A Logical Approach. Oxford University Press, Oxford (1998)
14. Taniar, D.: Mobile Computing: Concepts, Methodologies, Tools and Applications. Information Science Reference, vol. II (2009)

Facilitating Computational Thinking through Game Design

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Abstract. While in the last decade the advancement of computer technology and the ever-expanding popularity of digital games have become increasingly evident, the potential of using educational games for learning in science, technology, engineering, and math (STEM) subjects has not been brought to the forefront for exhaustive investigations. This study delineates the design and development, the instruction, and evaluation of a digital game-based curriculum focusing on teaching computational thinking in an after-school game design workshop in a middle school in Taiwan. Through examining students' participation in game design programs, the researchers investigate the emergence of computational thinking skills in a group of middle school students. Taking into account the middle school students' emergent skills to think logically and abstractly, we argue that digital game-based learning (DGBL) via game design is a viable pedagogical tool for teaching students to think computationally as they engage in problem-solving tasks. The researchers pose that following the workshop, students would be able to perform the fundamental skills of computational thinking—decomposition, pattern recognition, pattern generalization and abstractions, algorithm design, and data visualization. The students would also demonstrate the capability to incorporate computational thinking skills into scenarios outside of the purview of the game environment.

Keywords: Computational thinking, game design, digital game-based learning (DGBL), science, technology, engineering, and math (STEM).

1 Introduction

Millions of people worldwide are playing video games and this phenomenon warrants the question as to why video games engross players into flow state and what exactly these players are learning. The humongous growth in the number of games produced; both for commercial and educational purpose, for gamers and the general population foreshadows that video games are no longer solely a medium for young males but an increasingly global mass medium for people of all ages and genders. Video games warrant attention not only for their popularity but also for their socio-cultural and aesthetic elements potentially conducive to learning. During the past decade, studies

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related to the use of digital games for learning have emerged and digital game-based learning has become a legitimate field of study following the serious game initiative in 2002.

While looking at different media effects, Michael and Chen (2006) observed that "when considering the educational value of books and movies, it has been observed that those books and movies that attempt to preach less have the greater effect" (p.17). In other words, when the intended message or moral is stated blatantly or apparently, the message tends to be ignored, this is often the case in formal educational settings. On the other hand, the effect can be greater when messages are built into the situation on integrated more subliminally. Therefore, it is good to look at serious games as they are new mechanisms which combine video games with education for purposes of informing, training, and teaching. The messages in games are usually picked up in the game rather than taught explicitly. Serious games expand the value of training manuals or films by allowing players to learn while they play and apply what they have learned in immediately related contexts during game play. Therefore, one is put into a simulated virtual setting where the message is embedded into play.

Gaming research provides positive evidence of the effects digital games can have on learning – specifically in the areas of science, technology, engineering, and math (STEM). Barab et al. (2007) found that *Quest Atlantis* can be leveraged as a virtual environment where students could actively engage in socio-scientific inquiry to solve water pollution problems. Furthermore, Rankin et al. (2008) studied the effect of a massive multiplayer online role playing game (MMORPG), *Ever Quest,* in ESL classes for college-age students. These researchers found that the treatment group was more successful in L2 vocabulary acquisition than the comparison group (not exposed to the gaming application). Further studies, such as Papastergiou (2009) evaluated the learning effect and motivational pull of a science computer game for learning. In this game students learned about computer memory concepts by playing a game in their computer science class. These findings showed that the gaming approach was more effective in promoting students' knowledge of computer memory concepts and more motivational than the non-gaming approach. Research suggests that digital games with a built-in purpose can go beyond providing entertainment for players, stretching the purpose for playing games to more meaningful ends—healthcare, training, politics, advertisement, and more importantly education. Digital games for the 21st Century learner are essential tool for the future of education. Critical thinking concepts are one major element that is lagging behind in schools – games are an area where thinking critically, making decisions, and solving problems are fostered in a motivating and 'safe' environment. Players are able to experiment and try out newly learned concepts in a low stakes setting while receiving 'just in time' and 'on-demand' information.

This study investigates how digital game-based learning (DGBL) via design pedagogy and a researcher-developed curriculum can be used to foster students' learning of computational thinking (CT) skills. We contend that digital games can be powerful media through which computational thinking skills—decomposition, pattern generalization and abstraction, pattern recognition, algorithm design, data visualization—can be learned and practiced. Studying how K-12 students develop computational thinking skills through games design poses significant implications for educating our 21st century learners in the core subjects of STEM.

2 What Is Computational Thinking

One important skill for the 21st Century learner is to obtain the ability to garner, analyze, generalize, and visualize information gleaned and gained from multiple media sources. These data came in multiple modalities which require learners to use not only their traditional literacy skills but also use forms of new literacies—digital literacy and technological literacy—with the aim to successfully navigate the seemingly boundless world of informational technology. For successful navigation in the age of the computer technology, the researchers contend that using computational thinking to critically analyze and solve problems is a skill that demands immediate attention.

Wing (2006) stated that computational thinking confronts the riddle of machine intelligence: What can humans do better than computers? And what can computers do better than humans? More fundamentally, computer thinking addresses the question: “What is computable?” (p. 33). As of today, we still only know parts of the answers to such a question. However, Bundy (2007) posed that computational thinking is pervasive because it enables us to confront new kinds of questions, search for new kinds of answers, formulate new hypotheses, operationalize new theories, and establish new thinking patterns. Today, computational thinking is not something only computer scientists have to be adept at but everyone, it is a skill needed by all. Just as in the past literacy has been a skill that all individuals need to obtain to be successful members of society, now being able to ‘read’ or better yet ‘think computationally’ is a must. This point is driven home by Wing’s (2006) statement: “Ubiquitous computing was yesterday’s dream that become today’s reality; computational thinking is tomorrow’s reality” (p. 34). Computational thinking is changing the way we think because computational thinking has become an integral part of our everyday life.

3 Computational Thinking in K-12 Classrooms

To synthesize information and create new ideas demands one to reflect on thought processes, to consider how data is manipulated, and engage in generalization and abstraction based on computer science concepts. In order to encourage computational thinking in the classroom, Wing (2008) argued that teachers should ask the types of questions which explore how the use of technology can lead to problem-solving. Questions such as “How difficult is the problem?”; “How can the problem be solved?”; “What is the procedure by which you attempt to solve the problem?” should be frequently used as prompts in K-12 classrooms to elicit computational thinking. One way to sensitize students to the notion of computational thinking is to expose them to engaging simulated environments. In simulations, students can be encouraged and directed to think about ideas, representations, and data. To help students think computationally, simulations can be use to motivate students to delineate a mathematical representation of the problem under investigation. For instance, the simulation can be a visual representation of a story problem wherein students have to learn to manipulate with symbols and concepts using skills learned in other disciplines.

Classroom learning activities aimed to foster computational thinking should allow students to recognize and describe scientific relationships among variables, predict behaviors and events, acquire procedural rhetoric for better understanding of subjects, and ultimately establish a computational thinking skill set. Computational thinking skills can be built on the emerging new literacies: technology literacy (the ease and ability to use technology to locate resources and manipulate them to problem solve) and media literacy (the comfortableness and capability of extracting information from multimedia sources).

While some in higher education can grapple with the abstract definitions and descriptions of computational thinking, others in K-12 levels are not able to perform similar tasks yet. Cooper, Perez, and Rainey (2010) posed several reasons for this dilemma. First, computer science does not appear within the core topics covered in most high schools. Second, computer science as an elective topic tends to be disproportionately available to those in wealthy suburban schools. Furthermore, there is paucity of K-12 computing teachers to be able to implement the needed skills. Piaget (1964) posed four stages of cognitive development among children. Middle school children around the age of 11 are in the formal operational stage where they begin to think abstractly and are capable of deductive and logical reasoning. We contend this is a critical age frame for educators to teach children computational thinking skills as it seem both age appropriate and vital to their intellectual development. This study addresses the perceived gap in teaching children computational thinking skills in this developmental stage of their life.

In this study, the researchers focus on the fostering five specific computational thinking skills with which middle school students can us in game design tasks. Firstly, decomposition is the ability to break down a system into components or a task into procedures so that one can explain the elements of a process to another person or to a computer. Secondly, pattern generalization and abstraction is the ability to filter out information that is not necessary to solve problems and generalize information as necessary. Thirdly, pattern recognition is the ability to spot commonalities or differences that will help one make predictions or lead to shortcuts. The fourth computational thinking skill is the ability to develop step-by-step strategies for solving problems, also known as algorithm design. The fifth skill is data visualization, which is defined as information which has been abstracted in some schematic form, including attributes or variables for units of information (Friendly & Denis, 2001) or simply, the ability to represent complex networks or systems in visual representations. The current study builds on research and practice of teaching computational thinking and game design pedagogy and seeks to find correlation between learning game design concepts and acquiring computational thinking skills.

4 Game Design as Viable Pedagogy

Literature supports the notion that well-designed digital games can facilitate learning (Prensky, 2001, 2006; Gee, 2007, 2008). Well-designed digital games can facilitate learning because they are designed to contextualize learning based on a set of learning principles. Principles such as immediate feedback, sandbox, customization, and adjustable difficulty motivate players to work within their regime of competence with the problem space presented by the game (Gee, 2003). Research has identified that games can expose children to a design perspective that employs forms and practices viable both to professional and academic disciplines and can help children develop language and literacy skills (Gee, 2003; Games, 2008). The language and representations in modern video games is flexible and multimodal (incorporating images, print, audio, video, and movement) and hence Gee (2003) argues that playing video games requires multiple forms of literacy skills—digital literacy, technological literacy, and game literacy—by which gamers resort to when attempting to actively and critically approach game content and game play. We contend that a learner's ability to consolidate these different forms of literacy skills is critical in predicting approaches and performances in game design. Through adopting this designer perspective and the language of game design, children as designers are able to learn situated meaning of tools, roles, and representations in the context of a discourse (Gee, 1996). These novice designers will, through practice and iterative game design, become members of a specific community through adopting the "identity kit comprising of ways of doing, being, talking, and thinking" (Games, in press). And therefore they are now members of a specific community – the gaming community.

5 Theoretical Framework

The foundation on which this study rests are the theoretical underpinnings of the situated learning theory (Lave, 1988, Lave & Wenger, 1991). This theory poses that learning occurs in a context where the activity of learning takes place. In other words, learning is situated in a community of practice where students share similar goals for learning. Furthermore, situated leaning theory has been applied previously in technology-based learning contexts where the focus is on problem-solving skills (Cognition & Technology Group at Vanderbilt, 1993). In this study, the learning setting for the community of practice is the game design workshop where over time students become increasingly involved, through social interactions, with other novice game designers who hold certain beliefs and behaviors towards games and game design. Participants learn from the game design curriculum and apply this knowledge and skills in hands-on game design tasks. In other words, students' learning of computational thinking is embedded in the process of game design and other game design related tasks.

Building upon the situated learning theory, Wenger (2007) discussed the critical elements that distinguish a community of practice from others. These elements are the domain, the community, and the practice. The researchers believe that the participants in this study constitute a unique community of practice because the environment in which they function during the workshop contains all three distinct elements. The students' commitment to games is what will create a shared competence. Finally, the members of this specific community play games, talk about games, learn about game design languages and skills, and collaborate in teams. Through teamwork and expertise the students will engage and be able to learn from each other. To be a functional member in this community, these novice game designers have to engage in repeated problem-solving, resource sharing, and sustained social interaction. The above traits and interaction features define the subjects in our study as members of a community of practice as they explore, investigate, and cooperate to play games, think and learn with games, and explore game design elements.

6 Research Questions

In this study our working hypothesis is that DGBL, coupled with a researcher-developed curriculum and design pedagogy using game design programs, can help our learners learn and apply CT skills in game design and other related tasks. We investigate the following research questions in this study:

1. To what degree does DGBL based on a game design curriculum and design pedagogy help middle school students develop computational thinking skills?
2. How does DGBL using different game design programs facilitate middle school students' development of computational thinking skills?

7 Method

The after-school game design workshop will take place in a middle school in the northern part of Taiwan. A recruitment of ten to fifteen middle-school age students will participate in the workshop. Building on our prior pilot studies in the U.S. where the focus was on middle school age students and how they conceptualized, approached, learned, and materialized game design skills, this study will focus on middle school students' emerging development of computational thinking skills in a different social and cultural milieu. Participants will receive instruction on game design and engage with the curricular tasks and game design activities by using purpose-built game design tools—Gamestar Mechanic (www.gamestarmechanic.com) and Microsoft Kodu (http://research.microsoft.com/en-us/projects/kodu/). The major goal of the workshop is to train students to think like game designers, who look at not just the parts of a game but at the whole system of a game, allowing them to eventually participate in this system at a more meaningful level. The workshop consists of a progression of lessons to expose students to computational thinking, game design language and skills, and to help them better reflect on their learning progress as a member of the gaming community.

8 Data Collection and Analysis

Data will be collected from a number of sources such as reflective short answer questionnaires, field notes, student game design journals, and semi-structured interviews. The researchers will conduct participant observations throughout the workshop sessions. Triangulation of data will be conducted based on three forms of evidence—linguistic, behavioral, and artifact. These will all facilitate in determining participants' growth or lack thereof in the learning and application of computational thinking skills as related to game design and other problem-solving tasks.

Data will be analyzed to support or refute the claims of student learning pertaining to computational thinking skills through the researcher-developed curriculum and game design tools. The researchers draw on Geertz's (1973) "thick description" to strengthen the analysis and enhance the validity of this mechanism in conducting gaming research. As all research activities are conducted by the researchers, it is imperative for the researchers to have a solid foundation on data collection and analysis as the researchers are the ones who record and interpret the happenings of an event. Comparisons as to how middle school students from the U.S. and Taiwan may develop computational thinking skills along different routes will also be discussed.

9 Preliminary Findings and Future Work

The researchers' prior effort on studying how middle school age boys and girls in the U.S. learned about game design yielded several findings: These gamers grew in the understanding of games as systems and how these components work together in meaningful relationships (game design) to make a game functional; they developed growing sophistication in communicating with others in the workshop using distinct gaming discourse; they improved their understanding and application of computational thinking skills throughout the length of the workshop. The researchers expect to obtain similar results while studying gamers in Taiwan. However, the ways through which these gamers approach the learning of game design language, the actualization of game design artifacts, and the enculturation into a gaming community are hypothesized to be different than those of the gamers from the U.S.. Implications for teaching computational thinking would also be discussed.

References

1. Barab, S.A., et al.: Relating narrative, inquiry, and inscriptions: supporting consequential play. Journal of Science Education and Technology 16(1), 59–82 (2007)
2. Bundy, A.: Computational thinking is pervasive, http://www.inf.ed.ac.uk/research/programes/comp~think/
3. Cognition & Technology Group at Vanderbilt: Anchored instruction and situated cognition revisited. Educational Technology 33(3), 52–70 (1993)
4. Cooper, S., Perez, L.C., Rainey, D.: K-12 computational learning. Communications of the ACM 53(11), 27–29 (2010)
5. Friendly, M., Denis, D.: Milestones in the history of thematic cartography, statistical graphics, and data visualization. web document 174 (2001), http://www.math.yorku.ca/SCS/Gallery/milestone/milestone.pdf
6. Games, I.A.: Gamestar Mechanic: Learning a Designer Mindset through Communicational Competence with the Language of Games. To Appear in Learning, Technology and Media (in press)
7. Games, I.A.: Three Dialogs: a framework for the analysis and assessment of twenty-first-century literacy practices, and its use in the context of game design within Gamestar Mechanic. E-Learning 5(4), 396–417 (2008)
8. Gee, J.P.: Social linguistics and literacies: Ideology in discourses. Routledge, New York (1996)
9. Gee, J.P.: What Video Games Have to Teach Us about Learning and Literacy. Palgrave Macmillan, New York (2003)

10. Gee, J.P.: Good video games + good learning: Collected essays on video games, learning and literacy. Peter Lang, New York (2007)
11. Gee, J.P.: What video games have to teach us about learning and literacy, revised and updated. Palgrave Macmillan, Basingstoke (2008)
12. Geertz, C.: Thick description: Toward an interpretive theory of culture. The interpretation of cultures. Basic Books, New York (1973)
13. Lave, J.: Cognition in Practice: Mind, mathematics, and culture in everyday life. Cambridge University Press, Cambridge (1988)
14. Lave, J., Wenger, E.: Situated learning: Legitimate peripheral participation. Cambridge University Press, Cambridge (1991)
15. Michael, D., Chen, S.: Serious games: Games that educate, train, and inform. Thomson Course Technology, MA (2006)
16. Piaget, J.: Cognitive development in children: Piaget development and learning. Journal of Research in Science Teaching 2(3), 176–186 (1964)
17. Papastergiou, M.: Digital game-based learning in high school computer science education: Impact on educational effectiveness and student motivation. Journal of Computers & Education 52, 1–12 (2009)
18. Prensky, M.: Digital game-based learning. McGraw-Hill, New York (2001)
19. Prensky, M.: Don't Bother Me, Mom, I'm Learning!: How Computer and Video Games Are Preparing Your Kids for 21st Century Success and How You Can Help!. Paragon House, Minnesota (2006)
20. Rankin, Y. et al.: User centered game design: Evaluating massive multiplayer online role playing games for second language acquisition. In: Sandbox Proceedings of the 2008 ACM SIGGRAPH Symposium on Video Games, pp. 43–50 (2008)
21. Wenger, E.: Communities of practice. A brief introduction. Communities of practice, `http://www.ewenger.com/theory/`
22. Wing, J.M.: Computational thinking. Communications of the ACM 49(3), 33–35 (2006)
23. Wing, J.M.: Computational thinking and thinking computing. Philosophical Transactions of the Royal Society A 366, 3717–3725 (2008)

The Embarrassing Situation of Chinese Educational Game

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Abstract. With the fast development in recent years, the educational game has formed its own characteristics gradually. However, some problems have still not been resolved fundamentally through researches. Educational game has run into an embarrassing situation in design, in the choice for young people and in the face of their parents' doubt. This article summarizes these issues and analyzes them, hoping to provide references for the development of educational games.

Keywords: Educational Game, Embarrassing Situation, Young People, Parents.

1 The Embarrassment That the Commercial Computer Games Bring to the Educational Game

1.1 The Evil Reputation That the Commercial Computer Games Let Young People become Addicted Caused the Educational Game to Receive Implicate

The development of the computer game industry is rapid increasingly in recent years, and the computer game group is also huge day by day. The Chinese Young people Network Association has issued the third time The Report of Internet addiction Data of the Chinese Young people in 2009, which showed that the rate of the Internet addiction young people approximately composed 14.1% in our urban youth Internet users, and the population are approximately 24,042,000, which is basic impartial compared with 2005(Shown in Figure 1); In the non-Internet addiction young people, about 12.7% of young people have the Internet addiction tendency, and the population are about 18,585,000.

All the present situations of computer games cause the education and parents worried continuously, even regards those games as the disaster. In addition, a number of cases of student abandoned studies and misguided due to computer game addiction are reported from time to time, and some books complaints against computer games harms are published, which make the computer game left a bad impression to parents and educators, even no different with the spiritual opium. For most of them, children are prohibited from contact with anything associated with computer games, regardless of the quality. This also causes the educational game to fully suffer the dispute at the beginning of the birth.

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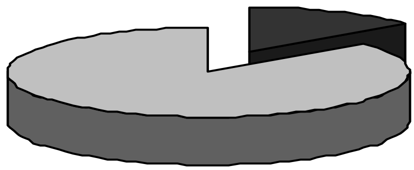

Fig. 1. The Rate of Internet Addiction Young People in Our Urban Youth Internet Users

1.2 The Evolution of Commercial Computer Games Causes the Educational Game Difficult to Define

As the parents and educators' cautious manner has also attracted the attention of computer games developers, some computer games companies begin to seek the path of combining the game with education, which reflects in the integration of certain historicity and popular science in games, the emphasis on the education ideas implicated in games in the propaganda strategy, and the design of anti-addicted functions such as fixed time reminds, the status authentication, and income reduce by half when overtime and so on, to ease public discontent on the computer games. With the implement of the Interim Measures for Online Games Management on August 1, 2010, more and more computer games and game communities have begun to more standardized on management and operation like the Mole Manor, and educational as one kind of propaganda strategy has been widely applied in, which causes a lot of children find an excuse that what they are playing are educational games when they playing them, and it is hard for parents and teachers to show approval or not at once. The outcome is the real educational games are lack of attention because the entertainment is not enough.

2 The Educational Game Design Is Faced the Embarrassment of Its Own

2.1 The Embarrassment on How to Make Balance between Education and Game

It becomes a thorny problem how to balance educational and game in the educational games research. China still lacks good educational games for young people, which is closely related to the design strategy of the development of such educational game. Infant children are usually more concerned about the game element of screen sound, and ease of operation. Youth games are generally more concerned about the background setting and story elements, the integrity of the game seriously. Parents and teachers emphasize the content of the leading teaching, training nature of the part of the game. They hope that the simpler and the fewer, the better the designing will be, and they even wished play educational games directly into the educational teaching software. However, the different expectations of educational games of young people, parents, and educators are directly to the balance of playfulness and educational issues, which is the most difficult part in the current design strategy involves.

The scholars attributed the game think playing through the game is an important learning view. Playing plays an important role on psychologically, on the social and intellectual development, and it also can be defined as a stimulus spontaneous activity inherent. Through a virtual path, the will enjoy the motives of the game after following the rules, players are encouraged to study within the satisfaction from intrinsic motivation. Educational scholars emphasize too much playability would undermine the educational function of educational games, the players will be really interested in the game and answer all kinds of sound effects, post-award winning, while they will ignore the knowledge inherent in the game Content. They may think those are just simple mechanical verbal exchanges, the reasons to the answers.

2.2 The Embarrassment on How to Connect Education and Game Nicely

Prevalent in domestic educational games, education and game are usually connected uncomfortably, which is the reaction of understanding in design and deviation of educational games. Many education experts viewed game generally as a teaching medium when they concerned about the educational value of the game. Under this influence, designers think unilaterally games as a tool for knowledge transfer. And because of the lack of the guidance of reasonable and feasible the design model, they only can graft the game elements to the related knowledge. This leads to a clear separation between educational content and the game environment. How to create an effective learning environment to achieve the integration of playfulness and educational, which is one of the burning embarrassments in educational game.

3 The Educational Games' Embarrassment to School Students

3.1 The Lack of Attraction in Educational Games

As educational and games are usually integrated uncomfortably, a lot of educational games still transfer directly based knowledge, and graft simple knowledge into the game content. They most use the monotonous ask-answer type, in which players can easily distinguish the content of the game and the content of education. There are educational "trails", which are not close to game action in educational games. If you put school students in a stiff stitching passive learning environment, it will let them have the feeling of being deceived. This will not only weaken the game entertainment, but also affect the study results. Educational Games shortcomings in the design stage led to the embarrassment that young people show old reception to them.

3.2 Single Types of Educational Game, the Lack of Playability

According to results of iResearchs' research survey, it showed that young Internet users in China in 2008 play the court games most, followed by casual game, respectively, large-scale online games, web games and console games.

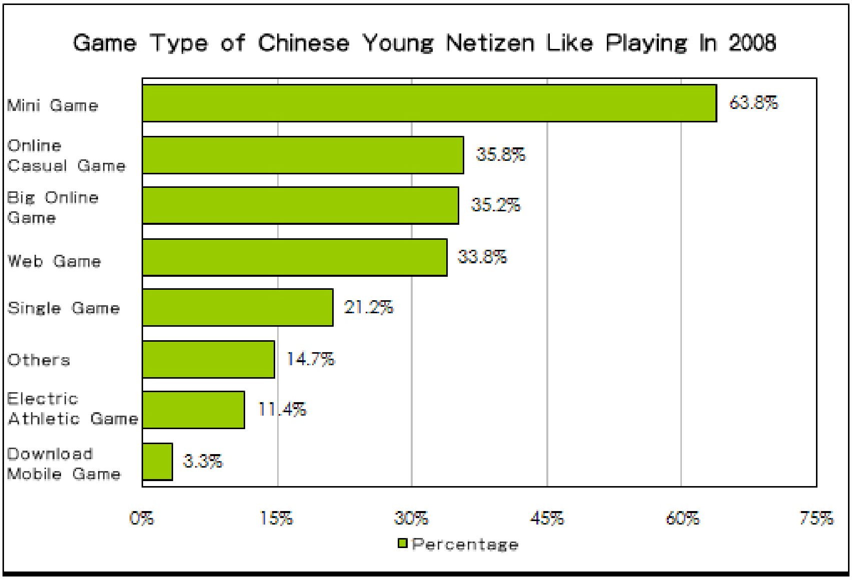

Fig. 2. Game Type of Chinese Young Netizen Likes Playing in 2008

Our educational games are known mainly in console games and virtual learning community. Such learning communities often modeled by primary and secondary school textbooks, and presented the vocabulary words, mathematical calculations, English words in the primary and secondary school textbooks to the players in the form of Flash games. These games are electronic exercises rather than games. They only remove exercises from books to computers. For the students who like studying, they can spontaneously study without electronic exercises. For the students who do not like learning, these easy electronic exercises only give them short freshness, they can not inspire the children's study interest and achieve the purpose of incorporating teaching into play.

4 The Embarrassment That Educational Games Confront Parents

4.1 Parents and Children Have Different Requirements on Educational Games

The survey on the Chinese parents' attitude of youngsters playing online games found that the degree of parents' tolerance is different. In the three age groups, opponents' in 12-14 age group account for the highest proportion, is 16.5%, and that's nearly 1.7 times of the 6-8 age group. Survey shows that between 9 and 14 years of age, the higher the age, the more strictly of parents on youngsters playing online games and the lower of support. Obviously, youngsters' and parents' requirements on educational games are totally different, one like relaxed, happy and fun, the other hope that there are more value of educational function, and hope the game has an immediate, obvious training effect, and the educational game should become an effective tool outside the classroom to consolidate children's knowledge. One side is the funny of the game while the children are interested in, the other side is, the value of its instruction and infotainment while parents prefer. Young people are users of educational games, while their parents are the real buyers. Faced with two very different requirements, educational games, how to choose?

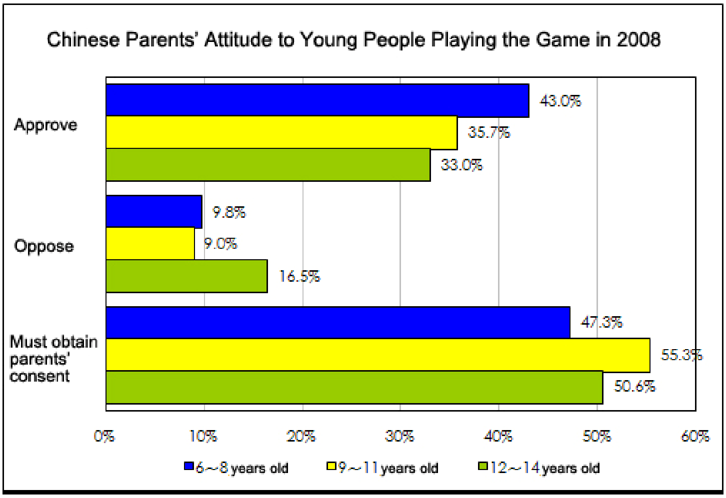

Fig. 3. Chinese Parents' Attitude to Young People Playing the Game in 2008

4.2 The Effect of Educational Games Haven't Been Fully Demonstrated to the Parents

With the popularity of the online games, many online learning communities have also emerged, which indeed played a very important role on teaching assistance and supporting distance learners at the beginning. But as the deepening of the research about the network learning community,, its defects are gradually exposed, mainly in the following three aspects: (1) "Skimping resources", which are just simply the electronic version of the textbooks that is commonly known as "the big move of the books " Most producers made them just for completing the task, rather for students. (2) "Cluttering resources", which although are not from the textbooks, but is a lot of material listed without further processing and extracting from which students can't benefit. (3) "profit-making resources", which provide paid services by inducing students to click on the material that is similar with the exam. Students must pay for browsing and downloading through the setting of permissions. The resources providers' goal is money first rather making practical materials for students, which made a very bad reputation instead.

Are the educational games do good to developing students' interest, improving the learning effect or the fake drugs? It made parents at a dilemma. It is important for educational games to prove its effectiveness.

Though the educational games nowadays face an awkward situation, it is a necessary developing process to experience. With the increasing popularity of the network, and its positive role accepted by the public gradually, parents, children also have changed the attitude towards the Internet. iResearch's research results in 2008 showed that parents' attitude towards children's surfing the Internet is lenient at the whole level. 53.4% Chinese parents are approving their kids surfing the Internet, 43.6% parents permit their children to access during the holidays only 3% young people secretly surf the Internet without parents' permission. iResearch's research believe that, Chinese parents have come to realized that the Internet is an important source of knowledge and entertainment with the popularity of the Internet and its widespread implementation of the multimedia teaching and the Internet has no longer been seen as a scourge. Chinese parents currently mainly control the time and the content of surfing the Internet, rather than simply rude refuse. Therefore, when browsing the progressive contents on the Internet and control the time, parents would be more tolerant. Many parents also said that they would spend money if it's beneficial to children's learning and effective though they don't truly understand the educational games. Opportunities should be seized to get rid of the embarrassing situations for Educational games by increasing more investments.

References

1. Chinese Young People Network Association: Chinese young people internet addiction report of investigation in 2009. Academic Report. Chinese Young people Network Association, Chinese Media University investigation and statistical research institute, Beijing (2009) (in Chinese)
2. CCTV Morning News: When children immerse Happy net, their parents are worried (August 27, 2009), `http://v.blog.sohu.com/u/vw/3081168`
3. Song, M.: The Construction and Application of an EFM Model in the Designing of Educational Games. Master Paper. Zhejiang Normal University, Zhejiang (November 2009) (in Chinese)
4. Gu, H.: Designing Educational Game Based on Fuzzy Strategy. Master Paper. Zhejiang Normal University, Zhejiang (February 2008) (in Chinese)
5. Zhao, H., Zhu, Z.: Educational Game International Research Trend and Enlightenment. Academic Journal 7 (2006) (in Chinese)
6. IResearch Market Consultation Limited Company: China Teenager Behavior Research Report in 2009 (in Chinese),
7. Academic Report. IResearch Market Consultation Limited Company, Beijing (2009)
8. Jin, K.: Building and Appliance of Parent-Child Interactive Games-Learning Community on B/S Mode. Master Paper. Zhejiang Normal University, Zhejiang (February 2008) (in Chinese)

Using Self-competition to Enhance Students' Learning

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Abstract. Although a set of competitive learning models have been proposed to benefit students' learning, they are limited in some aspects. Thus, there is a need to investigate other models. In this paper, we propose a self-competition model, in which students use avatars to represent their learning status. In addition, the current statuses of their avatars are further compared with the past statuses of their avatars. Through the self-competition model, students might be benefited.

Keywords: Game-based learning, competition, avatars.

1 Introduction

In recent years competitive learning attracts increasingly research attention. One of reasons lies in the fact that competition is an immediate and effective approach. Nevertheless, since competition involves the process of social comparison, in which students are exposed to numerous comparative information, it would significantly influences students' development of self-concept [1]. To prevent possible negative influences, previous works have proposed some mechanisms to enhance competitive learning, such as anonymous mechanism [2], group mechanism [3], and surrogate mechanism [4]. Nevertheless, since these mechanisms are limited in either learning effects or application contexts, there is a need to continually investigate other competitive mechanisms.

To this end, in this study we propose a self-competition mechanism and further investigate its effects on students' perception and learning achievement. More specifically, self-competition refers to each student competes against himself/herself rather than other students. Such a competitive mechanism, on the one hand, focuses on self-reflection and self-improvement so that the pressure resulting from social comparison might be released. On the other hand, self-competition also highlights the level of improvement between what students had learned in the past and what they have mastered in the current moment. This comparison information could motivate them to improve their learning status. Underpinned by these design rationales, a My-Avatar system is developed, of which functions would be described in the following sections.

2 My-Avatar System

The My-Avatar system involves two major components: one component is avatar component, and the other is self-competition component. Firstly, avatar component

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refers to using avatars to represent students' learning status. More specifically, a student's learning status is represented as the attributes of his/her avatar. By doing so, the student could understand his/her learning status through observing his/her avatar's attributes. This design is suggested by the concept of open learner model (OLM), which collects students' learning status and stores in an accessible model so that the students can understand their learning status as well as initiate further interactions [5].

Secondly, self-competition component involves several rounds of learning activities, in which students' learning status in the current round would be compared by the previous round. More specifically, in this study the subject domain is Chinese idioms. During learning process, the mastery levels of idiom usage in the previous and current rounds are listed comparatively so that the student could clearly know the details. In other words, the result of the self-competition is determined by whether they have made efforts in improving their learning status. By doing so, the student could know how to improve his learning status if he/she loses the competition.

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References

1. Mussweiler, T.: Comparison processes in social judgment: Mechanisms and consequences. Psychological Review 110, 472–489 (2003)
2. Yu, F.Y., Chang, L.J., Liu, Y.H., Chan, T.W.: Learning preferences towards computerized competitive mode. Journal of Computer-Assisted Learning 18, 341–350 (2002)
3. Slavin, R.E.: Cooperative learning: Theory, research, and practice. Prentice-Hall, Englewood Cliffs (1990)
4. Chen, Z.H., Liao, C.C.Y., Chien, T.C., Chan, T.W.: Animal companions: Fostering children's effort-Making by nurturing virtual pets. British Journal of Educational Technology 42(1), 166–180 (2011)
5. Bull, S., Kay, J.: Student models that invite the learner in: The SMILI open learner modelling framework. International Journal of Artificial Intelligence in Education 17(2), 89–120 (2007)

Towards an Open Source Game Engine for Teaching and Research

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Summary. Understanding how games work and how to create them has recently become important for disciplines other than computer science as well. If students without in-depth programming experience are meant to directly interact with a game engine, an off-the-shelf product will not fit. This paper presents "Fabula", a custom-made software that comprehensively addresses associated issues.

Python became the programming language of choice for the project since it is easy to learn, provides cross-platform compatibility and offers a comprehensive standard library. The actual graphic and display module is *Pygame*, a very popular game creation framework for Python. This software stack ensures an accessible, yet powerful application core and undemanding cross-platform 2D visuals.

Our students should be able to create games without being exposed to the technical layer, conveniently accessing the built- in game world instead. The main abstractions of the world are *Rooms* and *Entities*. A *Room* represents an enclosed location as a graph of discrete positions. An *Entity* object represents a virtual character (player or non-player) or an item. Each Entity resides on a node in the Room's graph. The engine defines a series of possible actions that a player can take, derived from classical adventure games. This abstraction aims to be intuitive to people who have not been involved in game development before, while at the same time being general enough to fit several genres.

The Fabula engine comprises a client and a server part. They communicate by sending *Events*. Each part consists of an *Engine*, a *Plugin* and an *Interface*. The *Interface* encapsulates the network transmission of messages. An *Engine* manages the game state, receives messages from and sends messages to the *Interface* and regularly calls the *Plugin*. A *Plugin* serves different purposes in server and client: the *Serverside Plugin* implements the game logic, while the client-side Plugin implements the *User Interface*, the graphical rendering and the point of interaction with the user.

The first public version of Fabula has been released in January 2011 under the General Public License (GPL) and runs on GNU/Linux and Microsoft Windows. We plan to use an extended Technology Acceptance Model (TAM) alongside the introduction of Fabula at the University of Education Weingarten to evaluate how the software helps students to explore the creation of enjoyment, emotional responses and social experiences in a game context, while trying to keep the hassle with technical details at a low level.

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Game Design Considerations When Using Non-touch Based Natural User Interface

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Extended Abstract. In recent years, the advancement in gaming interface has paved ways for faster and more interactive gameplay. There is now an increasing trend of using Natural User Interface (NUI) for computer games. This has also brought forward new challenges in game design and using non-touch based NUI in games is not simply replacing the existing interaction techniques. A lot of new game design considerations must be carefully thought out, planned and implemented, or otherwise the gameplay will suffer and, could cause frustration and dissatisfaction to the players. This paper discusses non-touch based Natural User Interface (NUI) and the factors that need to be considered by designers of games in designing games that uses this new user interface. Many considerations must be addressed to create the effective user experience when using NUI. This paper provides a framework of game design considerations that can be classified into three main categories: (1) user based analysis, (2) function based analysis, and (3) ambient based analysis. In this paper the following considerations have been identified and they fall under these three main categories:

1) User based analysis
   - Target Audience
   - Genre
2) Function based analysis
   - Players' Perceived Playability
   - Gaming Space Requirement
   - Suitable Gestures
   - Gestural Control
   - Multi-Player/Single Player
3) Ambient based analysis
   - Speech Control & Audio Elements
   - Iconography
   - Types of Display Screen

Since the use of NUI is a new phenomenon in games, the design considerations presented in this paper are by no means exhaustive. However, the discussions provided in this paper can reveal potential areas for future research in the field of non-touch based NUI for games.

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Effects of Type of Learning Approach on Novices' Motivation, Flow, and Performance in Game-Based Learning

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Abstract. This study employed a quasi-experimental design to examine the effects of learning approach on learners' motivation, flow experience and performance. The research framework consisted of pedagogy, content and technology aspects. For the pedagogy aspect, type of learning approach was employed to engage the learner in game-based learning. For the content aspect, the game-play activity was conducted to enrich the learner in understanding programming concepts. The content includes the programming concepts, variables and control structure. For the technology aspect, the game design tool, *Scratch*, was employed to empower the learner in trial-and-error practice to express the ideas they acquired. The instruments utilized in the present study were *motivation questionnaire, flow experience questionnaire,* and *project grading rubrics*.

The experiment was conducted in a 7-week session of learning basic programming concepts. The experiment includes two phases, the game-play and game design phase. The active exploration approach employed game-play of *Flash* games first. After that, learning activities on programming concepts using *Scratch* were provided for learners to practice their acquired knowledge and concepts. In contrast, the tutorial approach employed learning activities on programming concepts using *Scratch* first. Then game-play of *Flash* games were employed and served as an application context for learners to enhance their acquired knowledge and concepts. The difference between the active exploration group and tutorial group were the sequence of game-play, game design activity and the support strategy. The active exploration group received the metaphors during the game play activity to facilitate the understanding of programming concepts, while the tutorial group received the demonstration.

The results showed that (1) those learners who received active exploration possessed higher learning motivation and flow experience than those learners who received tutorial activity, (2) performance on the project for learners from both learning activities was the same, and (3) game-based learning could engage the learner with higher motivation and flow experience in programming learning.

Keywords: game-based learning, motivation, flow experience, programming concept.

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Behavioral Traits of the Online Parent-Child Game Players: A Case Study and Its Inspirations

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Abstract. By examining the online parent-child game entitled Island Survival, this paper probes into the behavioral traits of parent-child players by means of case study. The research mainly focuses on the following three points: (1).What kind of behaviors do the players conduct in the Online Parent-Child Game? (2). How many types of family relationship can be concluded on the basis of analyzing the players' behavioral traits? (3). With different types of family relationship sampled, check whether those types of family relationship are in accordance with the degrees of family intimacy based on the adaptive scales(FACESII-CV) or not. In the experiment, we choose students of two classes in a junior high school, as our samples, totaling 60 pairs of parent-child who are invited to experience a kind of parent-child game for 8 weeks, accumulating the storable and renewable database by means of snap-shooting and the temporarily deposited database in the server in the operation of games by a passive information-driven and an active rule-driven accumulation, and analyzing the dynamic data from the players' behaviors; We also choose four pairs of typical parent-child players. By further analyzing the social relationships of the families taking part in the online game, the time spanning of the parent-child players, and the branch task success ratio of parent role in parental education, the parent- kid family are classified into three different types: harmonious type, constructive type and crisis type, according to the players' behavioral traits; more importantly, the way of classifying offers critical enlightenment to the design of online parent-child games.

Keywords: Parent-Child Games, Parent-Child Cooperation, Player's Behavioral Traits, Data Analysis.

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The Evaluative Criteria of Computer-Based Vocabulary Learning Games

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Abstract. For many English learners, vocabulary learning is viewed as a burden. Digital game-based learning carries numerous potential to draw learners' attention and help them learn information effectively. Many game-based learning systems claim to foster the learning process. However, not all the games are suitable for vocabulary learning. Our aim is to provide the selection criteria for teachers when they apply game-based vocabulary learning for teaching. In this study, we firstly collected the criteria on evaluating game-based vocabulary learning from the previous research. Sixty-six criteria are chosen and divided into four dimensions (teaching, game, society, and technology) and fourteen categories. Next, some criteria are selected from the sixty-six ones through English teachers. Finally the selected criteria are ranked and given the weight calculated by ROC (Rank Order Centroid) according to students' preferences.

Keywords: Vocabulary Learning, Digital Game-Based Learning, Selection Criteria.

1 Introduction

For most English learners, vocabulary learning is the biggest problem during their learning process. They often devote a great deal of time to memorizing lists of L2 (second language) words. But the outcome of vocabulary learning is often limited and even frustrating. Recently computer games have been widely integrated into educational field. Games do promote learning and trigger the learners' intrinsic motivation through highly engaging challenges and feedbacks they provide [1]. More and more game-based learning systems are generated to state the reinforcement of the learning development. It appears to be a good alternative way for English teachers to apply it into the teaching environment. Nevertheless, not all the games are qualified for learning. Thus we intend to provide the selection criteria on evaluating game-based vocabulary learning for teachers to choose appropriate vocabulary games.

2 Literature Review

2.1 Computer Uses in Vocabulary Learning

An increase in vocabulary knowledge can certainly lead to the improvement of reading comprehension [2][3][4]. For L2 readers, the most magnificent handicap is

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not lack of various reading strategies but insufficient English vocabulary [5]. L2 beginners should put most of their attention on word learning. Given explicit instruction, including direct memorization of some high-frequency lexical items and practice in the 3,000 common word families, they can become automatic in their word recognition and then be allowed to do the reading they find enjoyable [6].

Nowadays more and more interactive uses of CALL (Computer-Assisted Language Learning) and an increase in the integration of different kinds of media into the computer system have appeared [7]. Besides, computers are very patient about repetition and recycling. These traits fit very well with the requirements of vocabulary learning, especially for the beginners. Educators are immensely interested in developing game-based learning materials because the potential of games can develop learning by doing, trigger motivation and enjoyment, and so forth. Games are considered as a learner-centered learning approach. Once learners feel responsible for the whole learning, they are more willing to learn and do it actively.

2.2 Vocabulary Learning Games

Many learners find vocabulary learning boring. One possible solution to this problem is the application of vocabulary games. [8] classified vocabulary games into three categories: (a) Creative and fun vocabulary games, (b) Vocabulary guessing games, and (c) Vocabulary games and group work. [9] collected the relevant English vocabulary games commonly used today, and classified them into six main kinds: crossword puzzle, word search, quiz, hangman, match game, and word jumble. Since games do facilitate learning development, we should further look into the evaluative criteria on selecting computer vocabulary games.

[10] proposed the guidelines for evaluating effective vocabulary learning software from the perspectives of education and technological features. [11] made some other criteria for evaluating vocabulary games, including relevance, peer interaction, and so forth. According to the corroborative study proposed by [12], fifty-three evaluative criteria concerning the game-based learning system were developed and divided into three dimensions (teaching, game, and society) and twelve categories.

3 Methodology

The purpose of this study is to provide the criteria on evaluating game-based vocabulary learning for teachers. Firstly, we developed the sixty-six criteria by synthesizing the previous related research and literature [10][11][12]. The sixty-six criteria were classified into four dimensions (teaching, game, society, and technology), and fourteen categories, to name a few: Material Adaptability, Enjoyment and Pleasure, Cooperation and Interactivity, Computer software, and so on. Then the procedure of this study was divided into three stages and described in details as follows.

3.1 The Top Criteria Selecting (Stage One)

According to the sixty-six criteria drawn upon the previous studies, we designed a questionnaire administered by nineteen English teachers in a junior high school, Taichung, Taiwan. Based upon the results of the questionnaires, the means and standard deviations of each criterion were calculated. To make the questionnaire of Stage two much easier for students to fill in, we chose the top one/two item(s) from each category and formed a questionnaire with the nineteen criteria.

3.2 Ranking the Selected Criteria and Calculating the Weight of Each Criterion (Stage Two)

One hundred and forty-eight seventh graders (five classes in total) in a junior high school, Nantou, were conducted in this stage. They were required to evaluate each of the criteria by giving points from one to five (from very unimportant to very important). The means and the standard deviations were calculated, and the ranking of the criteria was arranged by the descending order of the mean score. Moreover, we used ROC (Rank Order Centroid)[13] to calculate the weight of each criterion, shown in Table 1. The algorithm of ROC is illustrated below:

$$w_i = \frac{1/R_i}{\sum_{i=1}^{n} 1/R_i} = \frac{n+1-R_i}{n(n+1)/2} \tag{1}$$

w_i is the weight of the ith objective R_i is the rank of the ith objective
i is the ith objective n is the total number of objectives

Table 1. Ranking of the criteria, along with means, standard deviations, and weights of the criteria

Rank	Criterion	Mean	SD	Weight
1	1.1.2 Trigger motivation	4.07	1.1	0.1
2	2.1.1 Fun and interesting	4.5	1.06	0.0947
3	1.2.1 Suitable for student levels	3.99	0.93	0.0895
4	2.3.3 Able to gain new knowledge	3.99	1.7	0.0842
5	1.2.3 Facilitating students' learning	3.95	1.09	0.0789
6	1.1.1 Fertility and correctness	3.93	0.99	0.0737
7	2.1.4 Simple and understandable rules	3.85	1.06	0.0684
8	4.1.1 Simple interface and user-friendly	3.82	1.02	0.0632
9	2.3.4 Promote the ability of problem-solving	3.82	1.09	0.0579
10	3.3.1 Able to be extensively used in teaching	3.8	1.25	0.0526
11	1.3.2 Provide the function of selecting the learning extent	3.79	1.01	0.0474
12	2.2.5 Different levels of difficulty	3.76	1.11	0.0421
13	2.4.1 Provide reasonable game rules	3.76	1.02	0.0368
14	2.6.3 Able to set the difficulty of the games	3.75	1.07	0.0316
15	3.1.1 Provide cooperative learning	3.74	1.15	0.0263
16	2.5.1 Able to expand the content of the game	3.39	1.16	0.0211
17	2.2.2 Provide specific goals	3.37	1.21	0.0158
18	4.2.2 Requirements for hardware equipment	3.33	1.32	0.0105
19	3.2.2 Promote the family interaction	3.05	1.35	0.0053

3.3 The Verification of the Selected Criteria (Stage Three)

To verify the selection criteria developed in this study, we designed a questionnaire and provided five vocabulary games for sixty-six participants chosen from two out of the five classes. The questionnaire includes two parts: (A) fill in every evaluation form after playing every single game and (B) after playing all the games, write the order of the five games (from the like to the dislike). The five games, namely (a) English Tank War, (b) English Gept 2010, (c) English Matsu's Blessing, (d) English Manager, and (e) Hastar Gept II are available on http://www.hastars.com/flashgame/.

To further analyze the difference between the two ranking results (Part A and Part B), we assessed the extent of the differences. As for the calculation of the differences, an example is that student No.1 ranked the five games (b)(d)(a)(c)(e) in Part A, whereas he/she ranked (d)(c)(e)(b)(a) in Part B. Game (a) was ranked of 3 in Part A and 5 in Part B. The difference of the two parts is 2 (5-3=2). As for Game (b), the difference between the two parts is 3 (4-1=3). The difference of Game (c)c is 2 (4-2=2). For Game (d), the difference is 1 (2-1=1). As for Game (e), the difference is 2 (5-3=2). The total difference scores for student No.1 are 10 (2+3+2+1+2=10). Frequency of each difference was listed in Table 2.

Table 2. Frequencies of the differences

Difference	0	1	2	3	4	5	6	7	8	9	10	11	12
Frequency	5	0	7	0	20	0	13	2	6	0	6	2	4
Average	5.52												

According to Table 2, the average score is 5.52. Five students out of sixty-six had the same order of rankings. The number of the frequency (6 or less than 6) is 45 (68% of all the participants). The difference of the two rankings was roughly acceptable deviation.

4 Conclusion

Numerous teachers are looking for effective ways to develop students' vocabulary knowledge. Game-based learning has become a popular way to enhance the language learning because games are attractive and could bear educational significance [14]. Therefore, we presented the evaluative criteria on selecting suitable vocabulary games for teachers. In addition, the weight of the criterion is provided for teachers. Most importantly, the criteria were established mainly from the perspective of the students.

References

1. Conati, C.: Merging Cognition and Affect in HCI: Probabilistic Assessment of User's Emotions in Educational Games. J. Applied Artificial Intelligence (2002)
2. Beck, I.L., Mckeown, M.G., Perfetti, C.A.: Effects of Text Construction and Instructional Procedures for Teaching Word Meanings on Comprehension and Recall. J. Educational Psychology. 74, 506–521 (1982)

3. Carnine, D.W., Freschi, R., Kameenui, E.J.: Effects of Text Construction and Instructional Procedures for Teaching Word Meanings on Comprehension and Recall. Reading Research Quarterly 17, 367–388 (1982)
4. Stahl, S.: Differential Word Knowledge and Reading Comprehension. J. Reading Behaviour 15, 33–50 (1983)
5. Baker, I., Haynes, M.: Second Language Reading and Vocabulary Acquisition: American and Chinese Readers Learning from Lexical Familiarization in English Texts. In: Coady, J., Haynes, M., Huckin, T. (eds.), pp. 130–152. Ablex, Norwood (1993)
6. Laufer, B.: Second Language Learning Acquisition: The Lexical Plight in Second Language Reading. In: Coady, J., Huckin, T. (eds.). Cambridge University Press, Cambridge (1997)
7. Otto, S.K., Pusack, J.P.: Applying Instructional Technologies. Foreign Language Annals 23(5), 409–417 (1990)
8. Sasson, D.: End of the Year Vocabulary Games: Tips and Strategies for Creating Fun Word and Sentence Games. NESTA Futurelab: Literature Review in Games and Learning. (May 21, 2008)
9. Hung, H.C., Young, S.C.: Constructing the Game-Based Learning Environment on Handheld Devices to Facilitate English Vocabulary Learning. In: 10th IEEE International Conferences on Advanced Learning Technologies (2010)
10. Wood, J.: Can software support children's vocabulary development? Language Learning & Technology 5(1), 166–201 (2001)
11. Cowan, J.: What are the essential features of a successful academic game? SAGSET Journal 4(2), 17–22 (1974)
12. Lu, Y.L.: The Corroborative Study on Taiwanese Cuisine and E-learning System. Project Report NSC92-2524-S-152-001 (2005) (in Chinese)
13. Hsieh, T.C., Tseng, F.C., Wu, M.Y.: A Study on the Vital Function Factors around Campus and the Implementation of the Platform (2010) (in Chinese)
14. Prensky, M.: Digital Game-Based Learning. McGraw-Hill, New York (2001)

The Importance and Use of Targeted Content Knowledge in Educational Simulation Games

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Abstract. While most current educational simulation games provide learners with gameplay experience, there is often a lack of focus on ensuring that desired content knowledge is learned. Students may focus on completing game activities without learning the targeted content knowledge, thus negating desired learning outcomes. We argue that to help students achieve higher learning performance, targeted content knowledge should be a specific focus in educational games. Thus, the present study explores the effects and usage of providing targeted content scaffolds in various ways as a step to understanding optimal placement and tasks for such scaffolds within games. Results suggest that providing targeted content scaffolds in educational simulation games helps students achieve higher learning performance, and that students should read the content scaffolds both before and during gameplay.

Keywords: targeted content knowledge, educational simulation games.

1 Objectives

This poster session presents a study examining the effects of providing targeted content knowledge about projectile motion in an educational simulation game, with the content scaffolds being presented in one of two conditions: before and during gameplay or only during gameplay.

2 Theoretical Framework

Players can spend large amounts of time completing the mechanics of a game (e.g., shooting) without actually focusing on or learning the targeted content knowledge [2]. One way to deal with this issue may be to enhance the learning of content knowledge in theoretically grounded ways by providing scaffolding through reference material that is parallel, or related to the to-be-learned content. However, this can break up gameplay, and leave players dissatisfied with the experience. Finding optimal ways to present such supports to enhance learning is the goal of this study.

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Providing content knowledge that is scaffolded through reference material could allow students to confirm their observations during the game and allow them to achieve embedded tasks. This would decrease players' frustration that could result from not being able to solve the game's challenges.

Based on working-memory theory [1], paying full attention to acquiring knowledge while playing would seem to be difficult. Thus, reading targeted content knowledge supports *prior* to gameplay, while allowing access additionally *during* gameplay to enhance "just-in-time" accessibility may be best, since acquiring knowledge beforehand could decrease the need to frequently search for information during gameplay. Moreover, prior reading could help students form a macrostructure in which information learned in the later process can be stored [3]. However, it is possible that only having "just-in-time" accessibility is sufficient and that prior reading may in fact lower the motivation to play. These two conditions: providing supports before and during, vs. during only, were tested in this study.

3 Methods

An award-winning and research-developed educational simulation game called TANK-Q (see Fig. 1.) was used as the educational simulation game. TANK-Q 's instructional goal is to teach principles of projectile motion. Players must navigate their own tank and shoot to destroy different enemies by manipulating the velocity of a projectile (a shell) and its shooting angle (the tank's cannon). In addition, the game also allows players to go to different planets with different gravities, so that they can observe how the projectile moves in different gravitational environments.

There are 9 levels in TANK-Q. Players must acquire a key and then travel in their tank to a lock to enter the next level while defeating enemies. A key is not displayed when a player enters a level. Players need to correctly answer a multiple-choice projectile motion question displayed on the top of the screen by shooting the correct answer tower that has a number representing an answer selection. They can find the answer by observing the results caused by manipulating variables in the game or by reading the in-game book information.

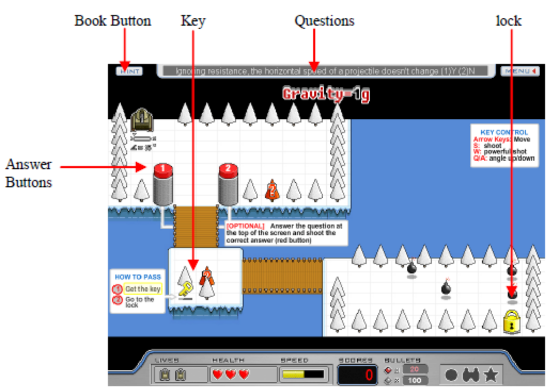

Fig. 1. TANK-Q- an Educational Game Teaching Projectile Motion

3.1 Participants and Procedures

Three 8th grade classes (A, B, and C) played TANK-Q for two sessions (50 minutes each). Students in Class A (N=27) were able to read content-related reference scaffolds for 5 minutes before playing the game, and had the scaffolds available for "just-in-time" use during the game as well. Class B (N=25) could access the reference scaffolds during gameplay only. Class C (N=27) were not provided with content reference scaffolds, and simply played the game. After the play session, students took a test about the principles of projectile motion. Two high school teachers, one who teaches technology and one who teaches physics, confirmed the test's content validity. Also, the school teachers confirmed that students' abilities and knowledge regarding physics and mathematics were equal across the three classes.

4 Results

An independent t-test was used to compare the mean post-test scores of Class A vs. Class B, and Class B vs. Class C. Results show that Class B's mean score (M=62.14, SD=16.82) is significantly lower than Class A's (M=75.65, SD=13.77; t=3.54, p=.01), but higher than that of Class C (M=55.79, SD=12.20; t=2.58, p=.02). The results suggest that the highest learning performance is achieved when content scaffolds are provided before gameplay, with access to these scaffolds available during the game as well. However, providing content scaffolds that are available during the game is better than not providing them at all.

5 Conclusion

The above results should be of interest to teachers and educational game designers. Teachers should suggest to students that they read background material before playing games, as this seems to facilitate the formation of macrostructures related to the target knowledge, and teachers should also allow students access to such materials while playing. Educational game designers whose goals include the learning of game-embedded content should provide targeted content scaffolds as part of their educational simulation games, perhaps through embedded content-related activities as a precursor to the "actual" game, and also embed scaffolds accessible within the game.

References

1. Baddeley, A.D., Hitch, G.J.L.: Working memory. The Psychology of Learning and Motivation: Advances in Research and Theory 8, 47–89 (1974)
2. Graner-Ray, S.: Gender-inclusive game design: Expanding the market. Charles River Media, Hingham (2003)
3. Kintsch, W.: The role of knowledge in discourse comprehension: A construction-integration model. Psychological Review 95, 163–182 (1988)

Development of Training System for Finger Dexterity: Use in Rehabilitation for Upper Body Paralysis

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Abstract. Occupational therapists use rehabilitation training to attempt to recover use of the fingers in people whose fingers have been paralyzed by brain damage or some other means. Our research aims to support some of this training using computer technology, and we are developing a rehabilitation system that is both small and portable. This paper will describe the finger training system that we have developed.

Keywords: handedness exchange, tangible device, rehabilitation.

1 Introduction

For people who have had functionality in their fingers paralyzed through brain damage or some other means, rehabilitation training is used to remember the functionality in their fingers they remembered before being paralyzed. Occupational therapists use training to support the rebuilding of the portion of patients brain that controls finger functionality. There is previous research with the goal of supporting some of this training using computer technology [1]. However, all the systems suggested are of a large scale. In order to bring about a small scale portable rehabilitation system, we are proceeding with research and development of training software and a training device.

2 Finger Training System

Occupational therapists often use pegboards for training to recover functionality in patients with upper body paralysis. This training is to increase dexterity of the fingers, by using the paralyzed hand to grab pegs, put them in the board, and using fingers to rotate the pegs. Patients perform these simple movements repeatedly.

2.1 Training Device

For rehabilitation, training of the thumb and forefinger are prioritized over training of the other fingers. The action of pinching is just that important in daily life. Therefore,

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we made the main frame of the tangible device in the shape indicated in Fig. 1, in order to be able to mimic the pinching action. The protrusion in the center of the device is where the user's fingertip is placed. By placing another finger along the part surrounding the protrusion, pinching can be carried out.

Fig. 1. Training Device

2.2 Training Software

By controlling the tangible device while watching the graphics on the display, users can imagine the act of pinching. The basic method for controlling the training software is the same as a pegboard. In other words, the action of grabbing a peg and moving it to a different location is repeated. Fig. 2 is an example of using the above tangible device in a tangram game. Training of the pinching movement can be carried out while enjoying the game.

Fig. 2. Training System

3 Conclusion

Here we have shown the development of a tangible device for rehabilitation training of the fingers as well as training software with some game elements included. Hand dexterity are judged based on spacing, timing, and grading. Spacing is the ability to move the hand in the proper direction. Timing is the ability to make the proper time adjustments for hand movements. Grading is the ability to use the proper amount of force for hand movements. Our system was developed with these components in mind. Development also took into account opinions and advice from staff working in medical facilities. In the next step, the effectiveness of our system in actual rehabilitation training will be evaluated based on the three points outlined above.

Reference

1. Brown, A.: Design experiments: Theoretical and methodological challenges in creating complex interventions in classroom settings. The Journal of Learning Sciences 2(2), 141–178 (1992)

Investigating the Impact of Integrating Self-explanation into an Educational Game: A Pilot Study

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Abstract. The purpose of this study was to examine the effect of integrating self-explanation principles [2] into a digital game-based environment on the students' acquisition of light and shadow concepts. 35 third graders were recruited and randomly assigned to either an experimental group or a control group. 16 students in the experimental group were required to play a game with self-explanation prompts, where 19 students in the control group played a game without any prompts. Students' conceptual understanding was evaluated through a pretest, and a posttest that occurred right after the treatment. The results revealed that in terms of the posttest, students who played the game with self-explanation features did not outperform those who played the game without any prompt. But, when comparing their improvement from the pretest, it was merely the students in the experimental group whose posttest scores were significantly higher than their pretest scores.

Keywords: Game-based learning, science game, self-explanation, digital game.

1 Introduction

Educational researchers have suggested that computer games (here after named games in the present study) can not only enhance students' engagement and motivation but also support their learning performance [1]. According to the *National Educational Technology Plan* [10], games can be an approach to provide an engaging and motivating environment for knowledge building and assessments. And if designed properly, games can become an ideal context to immerse students into abstract thinking of scientific phenomena as well as making sense of the complex concepts [3]. The positive impact of games on facilitating students' learning of science concepts has been indicated in many studies [4] [6]. Although games can foster students' knowledge building, some critics [5] pointed out that educational games may risk supporting the practice of factual information. That is, the players are simply experimenting with certain actions until their scores improve and no meaningful reflection on the outcomes takes place. Thus, there is an urgent need to integrate

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learning theories into the game design to engage the player into deeper understanding. Self-explanation may be one of the effective learning strategies. According to the researchers [9], self-explanation principles suggest that learning is enhanced when a learner is engaged in or are prompted to generate explanations to himself/herself during the activity. A number of studies have integrated self-explanation features into a multimedia environment and have received a positive impact, such as learning an AVL tree of data structure in a computer science course [11] and learning to solve mathematical equivalence problems in math [8]. Although self-explanation principles have applied to various subject areas, little research has been conducted to investigate the self-explanation effect in a game environment. Thus, this study intended to investigate the impacts of combining self-explanation principles with a game on facilitating a group of elementary school students' acquisition of science concepts.

2 Methodology

2.1 Participants

The participants originally included 58 third graders and they were recruited from a primary school in northern Taiwan. Excluding 23 students who dropped out or failed to complete the game, there were 35 students (15 females and 20 males), who were randomly assigned into either an experimental group or a control group. The experimental group consisted of 16 students (8 females and 8 males) and they were required to play a game with self-explanation prompts. The control group included 19 students (7 females and 12 males) and they played a game without any prompt. None of whom had received any formal instruction about the concepts of light and shadow.

2.2 Instrument

The learning objectives of the game implemented in the present study were to help the third graders learn light and shadow concepts. The targeted content was designed according to the textbooks and referring to the national curriculum standards for science in Taiwan [7]. The game consisted of two stages that were embedded into a scenario in which a princess was kidnapped and the player should pass the two stages in order to save her. The first stage mainly instructed the relationship between the height of a light source and the length of shadow. In the game, the player needed to manipulate the avatar toward a destination and control the height of the flashlight so as to keep the shadow of the avatar's head within the red path (see Figure 1). As illustrated in Figure 1, the player should click the arrow buttons so as to adjust the height of the flashlight. When failed, the avatar's shadow would be sucked up and the game made a scream as a negative sign. Each player has three opportunities and one can replay the game when failing all of them.

The second stage was designed to cover four concepts: 1) shadow change during daylight; 2) shadow change during nighttime; 3) shadow intensity; 4) shadow visibility under a shelter. Like Stage 1, the player should control the avatar toward a destination and keep the avatar as well as the avatar's shadow staying within the floor.

Fig. 1. A screenshot of the game context for Stage 1

The player, while manipulating the avatar's movement, must pay attention to the change of time and the avatar's shadow since the path was designed with different widths. The transformation of daylight and nighttime also is based on the change of the time. Time limitations of four and eight minutes were imposed on Stage 1 and Stage 2 of the games, respectively. Each player has to pass both stages within 30 minutes. If failed, the games would be led to the posttest (describe later).

The game included two versions, a base version for the control group and a self-explanation version for the experimental group. Both versions share the same features, except for the fact that the game of experimental group was offered a multiple-choice question whenever the player made a mistake (see Figure 2). The game would not continue until one of these options was selected.

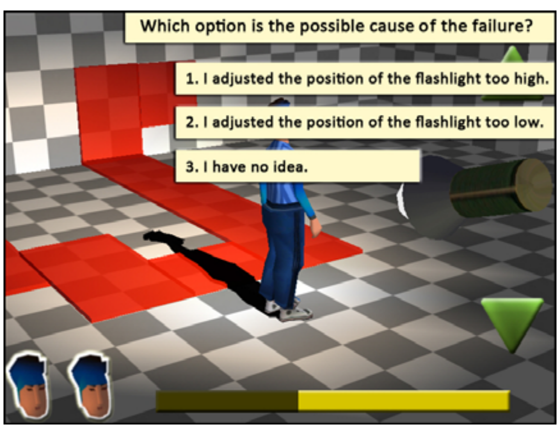

Fig. 2. A screenshot of the game with a self-explanation prompt

2.3 Procedure

The researcher provided a brief introduction in the beginning of the study. Since the game-playing instruction had been embedded into the game, the students were told to remain silence during the game playing and to raise their hands if they had any question. Each student individually played the game in their computer class. Before the treatment, the students took a pretest that consisted of 10 multiple choice questions. When either passing two stages of the games or over required time of 30 minutes, the posttest that shared the same test items with the pretest appeared. No time limitation was imposed on taking both tests. All the user information (e.g. buttons clicked and time spent) was recorded into a log for later analysis.

3 Results

Table 1 displays the mean and standard deviation of each group on the pretest and posttest. As shown, no significant difference (t = 1.79, p > 0.05) was found in the pretest scores of the experimental and control groups. This implies that the students from both groups might have statistically equivalent prior knowledge. However, no significant difference (t = 0.63, p > 0.05) was also found in the posttest scores of both groups. That is, students who played the game integrated with self-explanation did not outperform those who played the game of a base version.

Table 1. Comparison of the pretest and posttest scores between both groups

	Experimental group (Mean, SD)	Control group (Mean, SD)	*t*-value
Pretest	3.56 (1.41)	4.58 (1.87)	1.79 (NS)
Posttest	4.38 (1.75)	4.74 (1.63)	0.63 (NS)

NS, not significant.

When comparing both groups' improvement from the pretest, the results indicates that the posttest scores of the students in the experimental group were higher than their pretest scores (t = -2.21, p > 0.05). No statistically significant difference (p > 0.05) was found in the scores of the control group. This finding suggests that the game with self-explanation prompts had a positive impact on facilitating the students' acquisition of scientific concepts.

Table 2. Paired t-tests for the scores of experimental and control groups

	Group	Mean difference	SD	*t*-value
Pretest – Posttest	Experimental	-0.81	1.47	-2.21*
	Control	-0.16	1.83	-0.38

*p < 0.05.

4 Discussion and Implications

This study investigated whether a game with self-explanation prompts might help the students acquire light and shadow concepts. The results indicate that although the students who played the game with self-explaining features did not outperform those who played the game of a base version, a significant improvement from the pretest was identified in the experimental group. This reveals that adding self-explanation into the game context could promote students' learning science. This finding is also resonant to the study [9] suggesting that learning in a multimedia environment becomes effective when learners are more involved in active knowledge building (e.g. reflecting on the cause to their failure in the game) and in monitoring their learning process. In addition, why the experimental group did not outperform the control group may be summarized into several reasons. First, it is possible that the generation of the self-explanation effect may become apparent after a period of time. That is, probably after several weeks those in the experimental group may retain the targeted knowledge better than those in the control group did. Second, since this study is a pilot study, the statistically insignificant differences may be due to an insufficient sample size. Last, it is possible that forcing the players to respond a question during the game play may impede their flow experience so as to deteriorate their learning performance. Thus, when investigating similar topics in the future, it is suggested that future researchers should take the lasting effect of self-explanation principles into consideration and provide a retention test after a treatment. Further, the researchers should also pay attention to the player's flow experience while designing any prompt during the game play. It is also an interesting research topic for future studies to investigate how the students' flow experiences influence their learning performance.

References

1. Annetta, L., Minogue, J., Holmes, S., Cheng, M.: Investigating the impact of video games on high school students' engagement and learning about genetics. Computers & Education 53, 74–85 (2009)
2. Chi, M.T.H., Bassok, M., Lewis, M.W., Reimann, P., Glaser, R.: Self-explanations: How students study and use examples in learning to solve problems. Cognitive Science 13, 145–182 (1989)
3. Dede, C., Salzman, M.C., Loftin, R.B., Sprague, D.: Multisensory immersion as a modeling environment for learning complex scientific concepts. In: Feurzeig, W., Roberts, N. (eds.) Computer Modeling and Simulation in Science Education, pp. 259–282. Springer, Heidelberg (1999)
4. Hsu, C.-Y., Tsai, C.-C., Liang, J.-C.: Facilitating preschoolers' scientific knowledge construction via computer games regarding light and shadow: The effect of the prediction-observation-explanation (POE) strategy. Journal of Science Education and Technology (In press)
5. Kiili, K.: Digital game-based learning: Towards an experiential gaming model. The Internet and Higher Education 8, 13–24 (2005)

A Study on Exploring Participant Behavior and Virtual Community in MMORPG

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Abstract. The MMORPG is an interactive multiplayer online role-playing game. Players interact with each other in the virtual community of MMORPG having different behaviors due to the level of involvement and interaction. Players and players have different interaction in the communities through the game. The level of participation and interaction of players cause different behaviors in the game. Research data comes from those players who created their roles from 18pm to 24pm at the first day the game world started and their behaviors were continuity recording for 7 days. The results of the study found that players who attended to the virtual community were willing to spend more time and pay more money on the online game. Moreover, positive correlation was found between time and money players spent in the MMORPG. Furthermore, there is no difference between players' behavior in the game in different roles of genders.

Keywords: Flow Experience, MMORPG, Virtual Community.

1 Introduction

According to the previous studies, the online game is likely an entertainment-oriented information system which provides users game experiences and a variety of social activities [1, 2]. Some researchers believe that the game is a fantasy virtual community, including the user virtual environment, roles, and created stories and experiences [3]. Players would be easily addicted in the virtual community of the online game. Some studies indicate that there is an addicted phenomenon for the MMORPG players [4, 5]. The addicted experience affects the player's participative experience in the virtual community of the online game [6, 7]. Therefore, this study aims to investigate the correlation between addiction and participation in the virtual community of a MMORPG. More specifically, this study investigates players who joined the virtual community and the behaviors in the online game.

2 Literature Review

2.1 Massively Multiplayer Online Role-Playing Game (MMORPG)

MMORPG is a role-playing game, which features include direct interactions between the provided service and the game; players are able to interact with others for fun via

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synchronous connection, and enjoy the fun of the virtual characters [8, 9]. [10] indicated three main factors of MMORPG: (1) doing quests and achievements, (2) interacting with other players and (3) "leveling-up" the avatar. Therefore, MMORPG has stories and quests in the game, players interact with other players to explore different stories and quests will achieve different levels. MMORPG has the characteristics as below: enabling people to interact closely, real game background and rules, as well as high indulgence and imagination [11]. The virtual world where players in is filled with roles of real players. Players could easily interact with others.

2.2 Virtual Community

[12] defined that the virtual community is a variable number of users of consumer groups, and players interact to complete the goal of individuals and groups in the community. The virtual community is a cluster within a group of similar purposes and needs via network environment; it is operated through adequate people, emotions and interpersonal relationships in the virtual space [13-15]. [16] presented the virtual community was a new type of communication, and members in the community could exchange information and facilitate the exchange of mutual relations. Also, [3] divided the community into four groups: community of interest, community of relationship, community of fantasy and community of transaction; and the virtual community belongs to the fantasy community, which is a virtual environment created by members, and they play various roles, conduct online chat and games in order to achieve the purpose of entertainment.

There are numerous social behaviors in the virtual community, and millions of players interact via role-playing and form another social identity to enhance the personality role and its own unique feeling of immersion value [5, 11, 17]. Thus, players not only emotionally affect to the roles in the game, but also engage in a state of a really community [18, 19]. [12] defined that the virtual community is a variable number of users of consumer groups, and players interact to complete the goal of individuals and groups in the community.

2.3 Flow Experience

Flow experience was first proposed by [20, 21] to explain some of the people fully engaged in the activities. [22] used the flow experience to apply computer-aided environment, and indulged into the personal experience concept in web browser. More specifically, [12] indicated that the flow experience was a player playing the game during human-computer interaction, exploring the experience, and able to sense the spree; this state would motivate the individual to have a positive mood and satisfaction to fuel further explore. However, in other words, this type of status might lead to a degree of addiction to the game environment.

[12] applied the experience of addiction to the online games and suggested that it will affect the attitude of player to the game and their intentions of playing the game. [12] suggested that virtual community members will perceive indulgence in the community. The experience of addiction affects user's involvement in the community [6].

3 Methods

The method includes the research hypotheses and research sources which are described below.

3.1 Research Hypothesis

According to the literature review, hypothesis of this study are proposed:

H1 Players involved in the virtual community spent more time in the MMORPG.
H2 Players involved in the virtual community spent more money in the MMORPG.
H3 Time and money players spent in the MMORPG are positively correlated.
H4 Players of female roles are more involved in the virtual community than players of male roles.
H5 Players of male roles spent more money than players of female roles.

3.2 Research Sources

565 players' data were collected, which derived from the behaviors recorded for 7 days after the game roles were created, during 18:00 to 24:00 at the first day the game world started. The variables included: the gender of the players' roles, level of the players, money spent in the MMORPG, involvement in the virtual community, and time spent in the MMORPG. The involvement of the virtual community means the players have joined the families in the MMORPG or not. Table 1 shows that the result of the frequencies statistics for the players in the MMORPG.

Detailed analysis is as follows. For the level of the players, the lowest is 1 while highest is 39, with the average 22.66 (SD = 7.076) (Fig. 1). For the gender of the players' roles, male were 361 (63.9%) and female were 204 (36.1%). As for the involvement in the virtual community, 12 players were involved in the virtual community while 553 were not. Time spent in the MMORPG during a week ranged

Table 1. Frequencies statistics

variables	item	frequency	percentage
gender	Male	361	63.9
	Female	204	36.1
level	1-10	22	3.89
	11-20	207	36.64
	21-30	232	41.06
	31-39	104	18.41
money spending(NT$)	0-100	477	84.42
	101-300	24	4.25
	301-500	31	9.73
	501-700	9	1.59
	701-900	3	0.53
	901-1999	6	2.83
	2000-4000	5	0.88
virtual community	No	553	97.9
	Yes	12	2.1

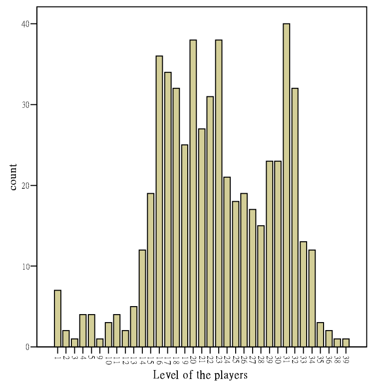

Fig. 1. Level of players

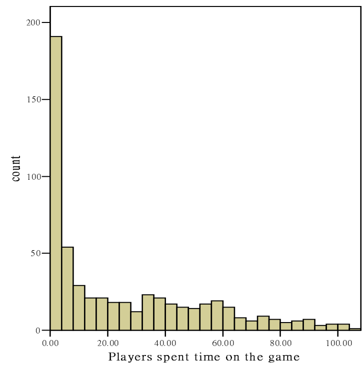

Fig. 2. Time spent of players

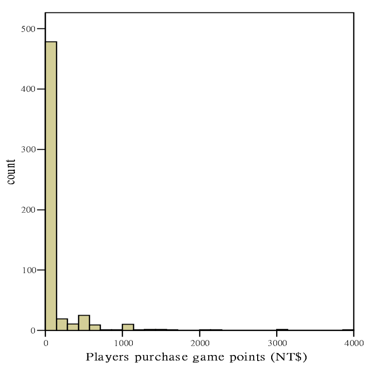

Fig. 3. Money spent of players

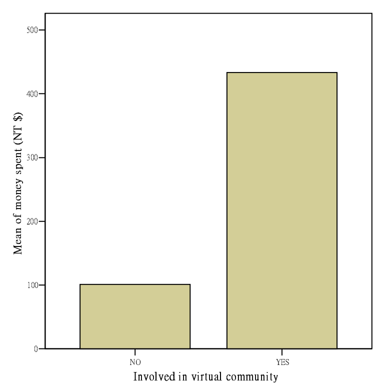

Fig. 4. Virtual community and time spent

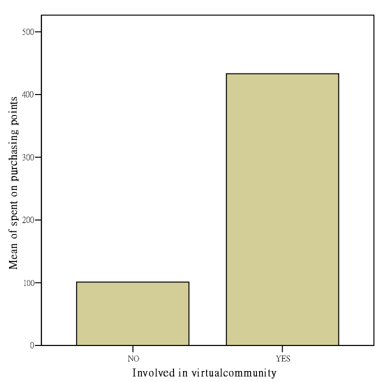

Fig. 5. Virtual community and money spent

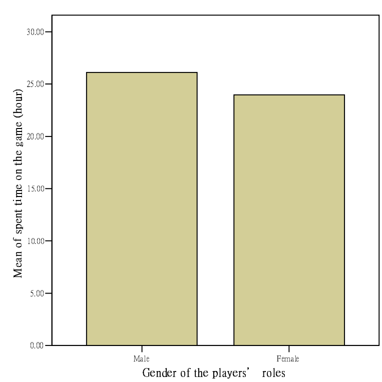

Fig. 6. Players roles and time spent

from 0.3 to 105.84 hours, with average 25.34 hours (SD = 27.15) (Fig. 2). The least amount money spent during a week was NT $0 while the most was NT $4,000 and the average amount was NT $108.03 (SD = 358.06) (Fig. 3).

4 Results and Discussions

4.1 Virtual Community and the Time Spending

In H1, it is assumed that players involved in the virtual community will spend more time in the MMORPG. According to the descriptive statistic, it is found that on average, players involved in the virtual community in MMORPG spent 41.40 more hours than those were not (Fig. 4).

The result of one way ANOVA suggests that the time which was spent by players involved in the virtual community in the MMORPG is significantly higher than those were not involved ($F = 28.64$, $p < .000$) (Table 2). Therefore, H1 was supported. The result indicated that players involved in the virtual community are more stuck to games.

Table 2. Virtual community and time spent one way ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Time Spent	Between Groups	20,128.96	1	20,128.96	28.64	0.000
	Within Groups	395,745.13	563	702.92		
	Total	415,874.08	564			

4.2 Virtual Community and the Money Spending

In H2, it is assumed that players involved in the virtual community will spend more money in the MMORPG. According to the descriptive statistic, it is found that on average, players involved in the virtual community in the MMORPG spent 332.36 more money than those were not (Fig. 5). The result of one way ANOVA suggests that the money which was spent by players involved in the virtual community in the MMORPG is significantly higher than those were not involved ($F = 10.29$, $p = .001$) (Table 3). Therefore, H2 was supported. The result indicated that players involved in virtual community spend more money in the MMORPG.

Table 3. Virtual community and money spent one way ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Money	Between Groups	1,297,394.05	1	1,297,394.05	10.29	0.001
	Within Groups	71,011,132.31	563	126,129.90		
	Total	72,308,526.36	564			

4.3 Time Spending and Money Spending

H3 assumes that the time and the money spend in the MMORPG are positively correlated. According to Pearson Correlation analysis, it is found that in MMORPG, the more time spent, the more money paid ($r = .359$, $p = .001$). For H3, the result shows that players who are more addicted to online games are more willing to spend more money in the game.

4.4 Players Role of Genders and Gaming Behaviors

In H4, it is assumed that the player of female roles will be more involved in the virtual community than those of male roles. In the light of descriptive statistics, it is shows that in MMORPG, players of female roles spent 2.6 hours less than those of male roles (Fig. 6). However, the result of one way ANOVA shows that different gender roles have no difference in virtual community involvement ($F = .82$, $p = .37$) (Table 4). Therefore, H4 is rejected. The result shows that different gender roles have no difference in the virual community involvement.

Table 4. Players roles and virtual community one way ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Money	Between Groups	605.62	1	605.62	0.82	0.37
	Within Groups	415268.46	563	737.60		
	Total	415874.08	564			

H5 assumes that players of male roles spent more money than those of female roles. According to descriptive statistics, players of male roles spent NT $23.89 more that those of female roles. The result of one way ANOVA shows that the amount spent in MMORPG is not affected by the gender of the roles ($F= .58$, $p=.45$) (Table 5). H5 is rejected. The result shows that different genders of roles have no difference in the virtual community involvement.

Table 5. Players roles and money spent one way ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Money	Between Groups	74389.10	1	74389.10	0.58	0.45
	Within Groups	72234137.26	563	128302.20		
	Total	72308526.36	564			

5 Conclusion

This study aims to explore the relation between involvement in virtual community as well as the players' addition and gaming behavior in the MMORPG. The results found that involvement in virtual community is indeed an important factor of players' addiction. H1 and H2 validates that players involved in game communities actually spent more time (F=28.64, p<.001) and were more willing to invest more money (F=28.64, p<.001) in the MMORPG. H3 proves that the players were more involved in a game, the more money they spent in it (r= .359, p=.001). This results is consistent with [23], indicating that through the interaction of online games, people's imagination meets each other on cyberspace and "virtual community" is therefore established. Social group is formed in this virtual community and it is dispensable from people's real world [12]. In real world, people are willing to spend time and money on things they favor; in virtual world, therefore, they are willing to have same investment, especially when the virtual world are inseparable from his real one. MMORPG enables people to connect to others at other ends of worlds in a virtual environment, which makes players indulge themselves not only in the quest in the games but also in the world of interacting with people [5]. Therefore, comparing to players who are not involved in the virtual community, involved ones are more willing to invest more time on and more possible to be indulged in the games [4, 12].

Another characteristic of MMORPG is that every player is able to get away from the gender and role of their real worlds and choose to be what roles they would like to be. H4 and H5 explore the differences between the gender of roles and the gaming behavior. The result shows that the gender of the roles in the online game did not affect gaming behavior. This is inconsistent with our perception of the role's behavior in the real world. However, in the virtual world, people can freely choose the roles he or she chooses and be not affected by his or her real sex. This is an attraction of MMORPG, and will be valuable to investigate.

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References

1. Hsu, C.L., Lu, H.P.: Why do people play on-line games? An extended TAM with social influences and flow experience. Information & Management 41(7), 853–868 (2004)
2. Van der Heijden, H.: User acceptance of hedonic information systems. MIS Quarterly 28(4), 695–704 (2004)
3. Armstrong, A., Hagel III, J.: Real Profits from Virtual Communities. The McKinsey Quarterly (3), 127–128 (1995)
4. Chou, T.J., Ting, C.C.: The role of flow experience in cyber-game addiction. CyberPsychology & Behavior 6(6), 663–675 (2003)
5. Yee, N.: Motivations for play in online games. CyberPsychology & Behavior 9(6), 772–775 (2006)
6. Chan, S., Lu, M.: Understanding internet banking adoption and use behavior: a Hong Kong perspective. Journal of Global Information Management (JGIM) 12(3), 21–43 (2004)
7. Koh, J., Kim, Y.G.: Sense of virtual community: A conceptual framework and empirical validation. International Journal of Electronic Commerce 8(2), 75–94 (2003)
8. Kim, K.H., et al.: E-lifestyle and motives to use online games. Irish Marketing Review 15(2), 71–77 (2002)
9. Ng, B.D., Wiemer-Hastings, P.: Addiction to the internet and online gaming. CyberPsychology & Behavior 8(2), 110–113 (2005)

10. Kryspin-Exner, I.: Gesundheit und neue Medien: psychologische Aspekte der Interaktion mit Informations-und Kommunikationstechnologien. Springer, Heidelberg (2009)
11. Manninen, T., Kujanpää, T.: The value of virtual assets-the role of game characters in MMOGs. International Journal of Business Science and Applied Management 2(1), 21–33 (2007)
12. Chan, C.M.L., et al.: Recognition and participation in a virtual community (2004)
13. Hagel, J., Armstrong, A.: Net gain: expanding markets through virtual communities. Harvard Business Press, Boston (1997)
14. Rheingold, H.: The virtual community. Citeseer (2000)
15. Rheingold, H.: The virtual community. Reading Digital Culture, pp. 272–280 (2001)
16. Hummel, J., Lechner, U.: Social profiles of virtual communities. IEEE, Los Alamitos (2002)
17. Buckingham, D., et al.: Computer games: Text, narrative and play (2006)
18. Ryan, M.L.: From Playfields to Fictional Worlds: A Second Life for Ariosto. New Literary History 40(1), 159–176 (2009)
19. Moore, R.J., Ducheneaut, N., Nickell, E.: Doing virtually nothing: Awareness and accountability in massively multiplayer online worlds. Computer Supported Cooperative Work (CSCW) 16(3), 265–305 (2007)
20. Csikszentmihalyi, M.: Beyond boredom and anxiety: Experiencing flow in work and play. Jossey-Bass, San Francisco (2000)
21. Czikszentmihalyi, M.: Beyond boredom and anxiety, San Francisco (1975)
22. Novak, K., Shahin, F.S.: A comparison of two image compression techniques for softcopy photogrammetry. Photogrammetric Engineering and Remote Sensing 62(6), 695–701 (1996)
23. Reid, E.: Virtual worlds: Culture and imagination (1995)

Exploitation in Context-Sensitive Affect Sensing from Improvisational Interaction

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Abstract. Real-time contextual affect sensing from open-ended multithreaded dialogue is challenging but essential for the building of effective intelligent user interfaces. In this paper, we focus on context-based affect detection using emotion modeling in personal and social communication context. It focuses on the prediction both of the improvisational mood of each character and emotional implication in direct related improvisational context during the creative improvisation. Evaluation results indicate that the new developments on contextual affect sensing enabled an affect inspired AI agent to outperform its previous version in affect sensing tasks.

In our previous work, we have developed a multi-user virtual improvisational platform for educational and entertainment purposes. It allowed up to 5 human users and one intelligent agent to be involved in one creative improvisation session. The AI agent has embedded an affect detection component, which detected affect from human characters' each individual turn-taking input (input contributed by an individual character at one time). The previously developed affect detection model was able to detect a wide range of emotions including basic and complex emotions and value judgments, but the detection processing has not taken any context into consideration. However, since open-ended natural language input could be ambiguous, sometimes contextual information is required in order to further justify the affect implied by the speaking character. Moreover in the Relevance theory, Sperber & Wilson stated that effective communication is not only based on the coding and encoding of messages but also regarding to the inferences of the communicative intention of the speaker. The inspection of the previously collected transcripts also indicates that the improvisational dialogues are multi-threaded. The conversations include not only descriptions of personal situations (e.g. worrying or embarrassment about personal situations) but also comments & responses aroused by social communication (e.g. arguing for different opinions). Therefore in this paper, we discuss contextual affect sensing integrated with emotion modeling of personal and social context to justify the affect conveyed in emotionally ambiguous input. In detail we employ the Bayesian networks for the inference of individual characters' improvisational mood and the algorithm of Adaptive Resonance Theory to sense the positive/negative/neutral implication embedded in social communication context.

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Improvising on Music Composition Game

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Abstract. Based on Dalcroze's Eurhythmics, this paper proposes a music composition game with an interaction platform for specific hand position and technique training, which includes rhythmic, melodic, and chord progression improvisation activities. Improvisation within this composition game means not to follow any formula or any pre-conceived ideas, and freely to respond to others (such as a computer game played by rules) by improvising rhythms, melodies, and chords under a structure of teaching music elements, so as to encourage active hearing, playing, and notating.

Keywords: Improvisation/Composition, Eurhythmics, Game, Interaction.

1 Introduction

Music regarded in the schools of today as of minor importance—cult of singing in the colleges of music of the 16th and 17th centuries—objections of exacted of students—futility of musical education that does not inculcate love of music in children—Necessity of gradually eliminating those who have no musical gifts, and forming special classes for children with inaccurate ears and voices or lacking in adequate rhythmic capacity—Syllabus of courses and classification of capacity in children—How to develop of "relative" pitch—Keys and scales—Exercises necessary to develop tense of rhythm—The step and the beat—Musical shading and improvisation [1].

Ninety years ago, Jaques-Dalcroze advocated a teaching method—eurhythmics to reform music education in France for equipping musician with better musicianship. Improvisation is one of three elements (eurhythmic, solfège, and improvisation) in Eurhythmics. In his "An Essay in the Reform of Music Teaching in Schools (1905)" Jaques-Dalcrosze pointed out: many good people suggested that the schools should not continue music education because there were no opportunities for children to display their attainments. Private music lessons were virtually confined to well-to-do families. Ninety years later, this phenomenon does not seem to change. This game design is to re-value his contributions in music education and propose a music composition game on improvisation, for the purpose of using improvisation as music teaching tool and providing everyone, including disadvantaged ones, with opportunities of improvising and composing in music.

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2 Reviewed Literature

2.1 Eurhythmics

Emile Jacques-Dalcroze (1895-1950) began his research with an attempt to solve his students' rhythmic problems in playing piano. His purpose was to stimulate feelings inside children so they could express or communicate these feeling through body reactions (body movements) and eventually through piano playing. As a result of his research, he concluded that rhythm was the basis of all art, and properly executed rhythm required complete mastery of movements in relation to energy, space, and time. He advocated that rhythmic movement should precede any other musical activities or learning. Training of physical movement was the essential activity. His central idea is how to connect daily life to rhythm in music. The resources of rhythm come not only from the human body (natural functions such as walking) but also from society and nature. Rhythm can be found in language, arts, poetry, dance, seasons, other live beings, and mechanical objects, even toys.

One of Dalcroze's ideas central to rhythmic activities is to connect exterior senses (hearing, seeing, touching, and moving) with interior activities in the brain (memory, memory retrieval, judgment, willpower, and imagination). The result of these activities is the ability to express musical elements—rhythm and dynamic energy—through body movement. For example, students should be able to express tempo (allegro, andante, accelerando, and ritardanto) with their body by listening to music. Dalcroze termed these activities as Eurhythmics. All the movement vocabulary that the student will experience in eurhythmic class includes movement in place (clapping, swinging, turning, conducting, bending, swaying, speaking, and singing) and movement in space (walking, running, crawling, leaping, sliding, galloping, and skipping) [2].

In Eurhythmics, after one year of rhythmic training, the students move to vocal exercises, mainly linking physical movement to vocal sounds to express musical ideas such as dynamics and accentuation. Dalcroze designed this aural training, called the study of Solfège, for students in their second year. These vocal exercises lead to exercises in the notation of melodies, polyphonies, and harmonic successions. The Eurhythmic activities can be motivated or initiated by speech, percussion, song, or piano improvisation, leading to ear training and movement, eventually leading to play a rhythmic instrument. Teachers can adopt Eurhythmics techniques to improvise initial activities, expressing speeds, durations, dynamics, and accents; producing rhythmic patterns, and training students' inner hearing. After being able to respond, improvise, and memorize the reaction agreed upon by the group, they can carry these activities into rhythmic instrument playing and composition. Following Dalcroze's ideas of improvisation leading to composition, in this composition game design rhythmic patterns are first to play on, and then melodic patterns (vocal song improvisation), finally completed by the triad chords.

2.2 Improvisation

The ways of improvisation as educational process include: (1) improvising to learn music; (2) learning to improvise music; and (3) improvise music to learn [3]. Campbell referred to Blacking's theory [4], that is, musician cannot be taught to improvise, but "does not mean improvisation is random, … all aspect of behavior are subject to a series of interrelated, structured systems, and when a musician improvises, he is expressing these systems in relation to the reactions he picks up from his audience." Improvisation comes from social interaction. However, Edward T. Hall [5] claimed differently. Hall reasoned that "while learning is the result of the instructional process improvisation is more closely allied to acquisition—learning while living within the culture—than it is a conscious process of learning sequentially how to do it." Blacking and Hall's arguments are similar. Either social interaction or acquired behavior, improvisation is not incidental event. It may be structured in situated condition to express human's ideas musically.

Campbell also referred to cognitive psychologists' idea about human behavior is direct result of repeated attempts to do it [6] [7]. Learning music and performance skills particularly requires such attempts. Learning to improvise involves complex tactile kinesthetic learning, visually reading music, aurally perceiving music, continuously acting conditioned muscle reflexes, constantly memorizing music, and then gradually assimilating by daily exercises. It definitely performs differently from other academic learning.

In "From sight to sound—Improvisational Games for Classical Musicians" Brockmann [8] explains: "The best way to start improvising is with a lot of structure and a little freedom, so that you don't feel overwhelmed. The beginning games are simple, without virtuosic technical demands. They are designed to wake up your ear and encourage active hearing." He thinks this will help students build up their confidence in hearing, playing, and singing. His game design, based on familiar building blocks, such as scales and arpeggios, is mainly for music students to practice under the context of ensemble. He also considers that listening skills is the first step toward improvisation; the more the students can hear and recognize¸ the more they feel comfortable to improvise.

2.3 Durations and Tempo

Langer [9] described music making as "The first stage is the process of conception, that takes place entirely within the composer's mind (no matter what outside stimuli may start or support it, and issues in a more or less sudden recognition of the total form to be achieved…This form is the 'composition' which he feels called upon to develop." Within the form are the musical elements conceived in composer's mind, part and parcel of the creative drive controlled entirely by an artistic imagination. Langer also termed music is "art of time". In music, time refers to notation of duration, the length of note, minimum molecular forming rhythmic patterns, and accumulated to length of a piece of music. Duration is one of the essential elements in music. Tempo controls speed of the execution of total notes. Imposing on durations, melodic lines and triad chords enrich the entire form. Improvising music is to execute the above essential elements within certain time frame.

2.4 Pentatonic Scale and Chord Improvisation

One music teaching element of Orff Schulwerk (1895-1982) approach is the use of the pentatonic scale that seems to always sound good while improvising [10]. Any vibrating sound creates overtones. Its first eight overtones, including doublings, are pentatonic scale—A, C, D, E, and G (Figure 1, Pentatonic scale on C). It has such universal quality. Pentatonic scale is commonly known as melodic construction of Taiwan-Siao-Diao [Taiwanese Minor Tune]. In western music pentatonic construction is also found in many cultures, such as Irish folksongs, Hungarian folk tunes, Native Americans, and so on. The two gaps between pentatonic scale (mi to so and la to do), together with other elements (rhythm, timbre, etc.), create big diverse music among these cultures. It is the minor feeling of Taiwan-Siao-Diao distinguished from others. Though selecting pentatonic scales to compose music in this game is for cultural implication, the melodic construction is not limited to minor scales (pentatonic scales start and end with re, mi, and la), giving more freedom of improvisation.

For the pentatonic melody, there are only two consonant triad chords (Figure 1). Only two consonant triads (C and A triads) for pentatonic melody can be played in, avoiding fa and si (ti). In improvisation on triad chords (piccolo or piano sound selections), two-part writing is to learn about basic and partial triad construction, the third and fourth above or below melodic line (Figure 1, Two-part writing examples), partials of inverted triads (Figure 1, Inversion of triad). After two-part writing, the player can choose sound sample of guitar and use guitar fret board to input triad chords of A, B, C, D, E, F, G, and A, for giving more freedom of chord improvisation. Still, the diminish B chord is excluded because its root cannot be included in guitar fret board on this interaction platform.

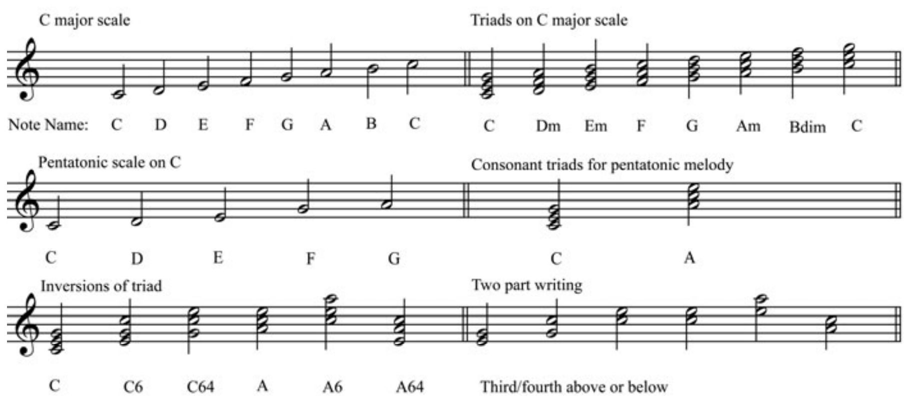

Fig. 1. Melody and triad chords used in this game

3 Design Content

3.1 Structure

Content structure of this game includes background story, game interface, game content, and interaction platform. Game theme is a “Forest Song”—a group of elves, with their Midas touch, changing an underdeveloped planet to become a full-of-life green planet. The story is an adventure to create a harmonic planet full of green plants, consisting leaves, flowers, and stems, implying symbolic meaning of structural elements of a music composition—rhythm, melody, and chords (harmony). The more songs are composed, the more harmonious of nature, eventually leading to a green planet that we all want.

The game progresses in sequence of rhythm, melody, and triad chord improvisation to accomplish a composition. They are assigned respectively by sound samples of percussive drum set (rhythm), piccolo/piano (melody), and piccolo/piano/ guitar (two-part writing for first two, triad chord for guitar), each giving different aspect of instrument playing and various combination of timbre.

Rhythm, melody, and triad chords are interrelated. In the beginning, the player has to follow the randomly selected tempo, in 44 meter structure, playing durations of quarter note, 8th note, or 16th note to create rhythmic patterns. Each level presents different measure number randomly produced by game, providing low to high challenges. Improvisation in each level is graded by accurately executed rhythms. After improvising a rhythmic passage, the player has to create a melody above the rhythmic passage, and then complete a piece of music with chords on them. The finished composition will be saved for later listening. The game is “…meant to be playing numerous times so the player can decide what he likes or does not like, and improvise what he wants next time [8].

3.2 Game Paying Flow Chart

The game progress is structured as a sequential learning of rhythm, melody, and triad chord, divided as easy, intermediate, and difficult levels. The flow charts of game progress and grading are listed as below: Figure 2, game playing flow chart; Figure 3, Score grading chart; Figure 4, Consonant/inconsonant chord judging chart (depending on triads illustrated in Figure 1).

3.3 Game Interface

Each level of the graphic interface design is related to themes of flower tree, graphic examples displayed as below are: Figure 5, the start page; Figure 6, the easy level starting page, displaying tempo as 60 beats per minute, with 16 measures; Figure 7, Easy level, starting improvising rhythmic pattern 1. The durations of quarter note, 8th note, and 16th note are selected for they are not too long to wear out patience or too short to discern accurate rhythms.

The melodic game page contains flower plants under two-line staff (Figure 8). The flowers grow while playing pitches accurately on rhythms. The player can choose melodic sound of piccolo or piano, and later in difficult level, piccolo, piano, or chordal sound of guitar to improvise on. Three improvisation levels respectively match three growing parts of flower plants—leaves, flowers, and stems. The upper part of this graphic design displays high/low pitches on two-line staff (for readable reason).

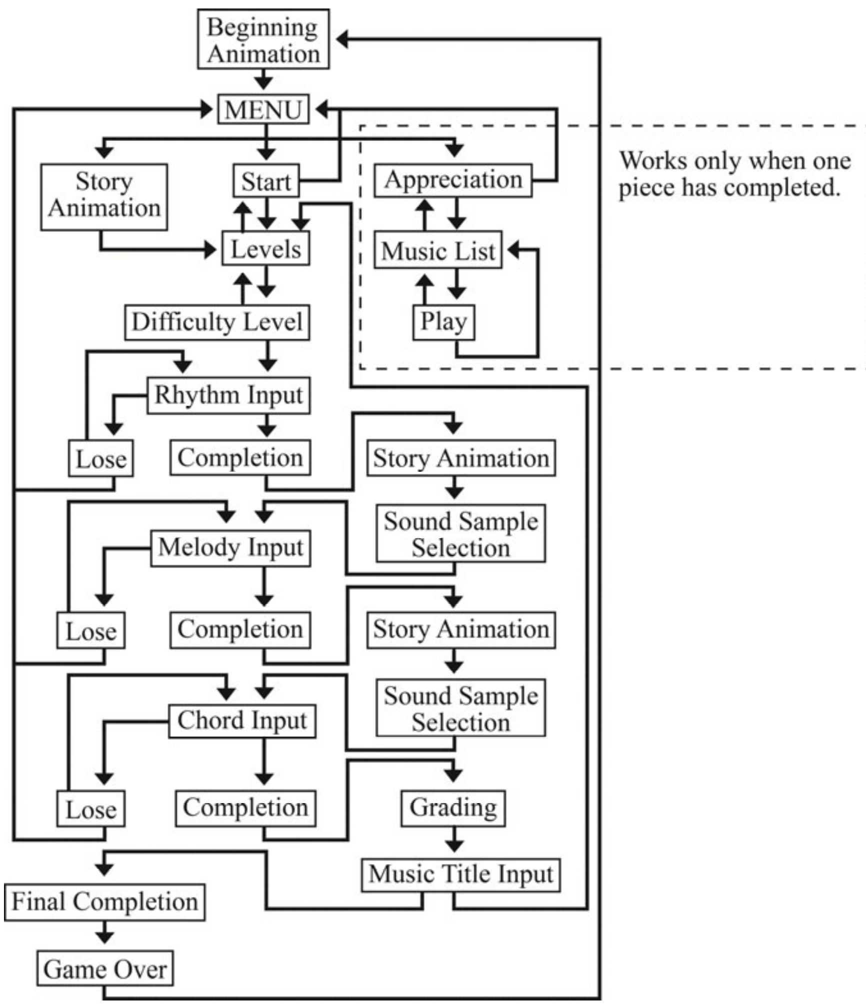

Fig. 2. Game Playing Flow Chart

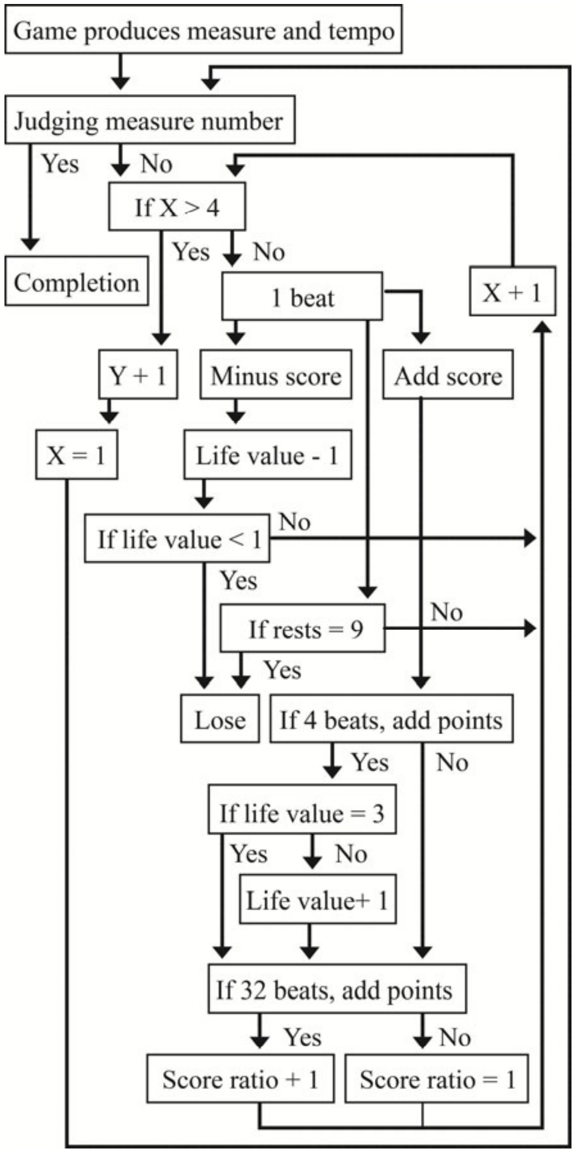

Fig. 3. Score grading chart

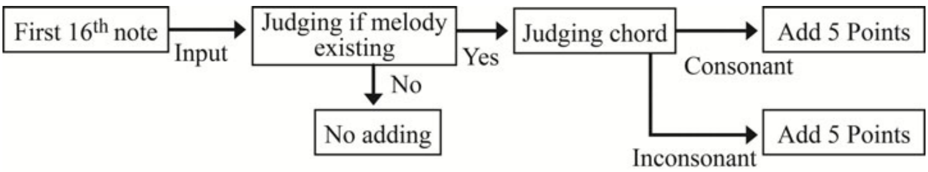

Fig. 4. Consonant/inconsonant chord judging chart

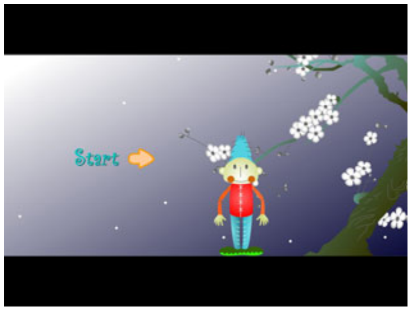

Fig. 5. Game start

Fig. 6. Easy level starting page

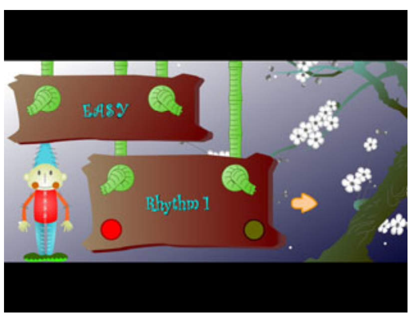

Fig. 7. Easy level rhythm 1

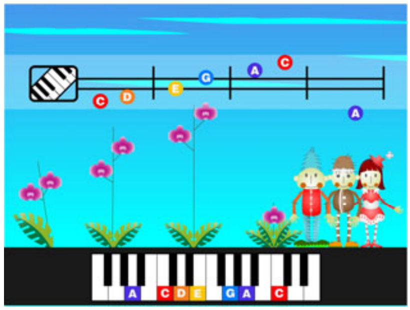

Fig. 8. Intermediate level for melody improvisation

3.5 Interaction Platform

Through considering imitation of real instrument and related playing gestures, positions, and techniques, interaction platform combines the devices of the drum set, keyboard, and guitar fret board. The player can play on the platform by good instinct. All the pressing buttons are produced by modifying the micro switch, connected to computer by USB, in other words, executed through USB connection. Interaction platform includes drum set map, pentatonic keys of piano keyboard (low A to high C), and guitar fret board (as in Figure 9-a, b, & c). The interaction platform front surface design is explained as the following A, B, C, and D sections:

A: In Drum set section, shape of circles and pies are drum set map for rhythm improvisation, based on relative positions of Jazz drum set, including high hat, crash cymbal, right cymbal, snare drum, tom 1, tom2, foot tom and bass drum centered. The size of each instrument is modified.

B: In Guitar section, the movable part imitates upper part of guitar fret board press locations and pizzicato sound effects (Figure 10 & 11 & 12); the fret board is exactly the same size as one of an acoustic guitar, from upper string nut to third fret, with 6 buttons of triad chord root, C on the first fret, F on the second, E on the third, A on the fourth, and D/G on the fifth. To complete chord improvisation, pizzicato stick (Figure 10) has to be pressed simultaneously with chord root button.

C: This section includes 4 buttons spread evenly working as basic function keys. Upper two buttons are left/right; lower two enter/cancel.

D: Keyboard section includes seven keys of low A,1 and C keys, D, E, G, A, and high C' imitating real piano keys of five finger positions; keys are shortened for naturally placing curving fingers. The surface of the buttons will be grooved for finger tip seating.

a. Front

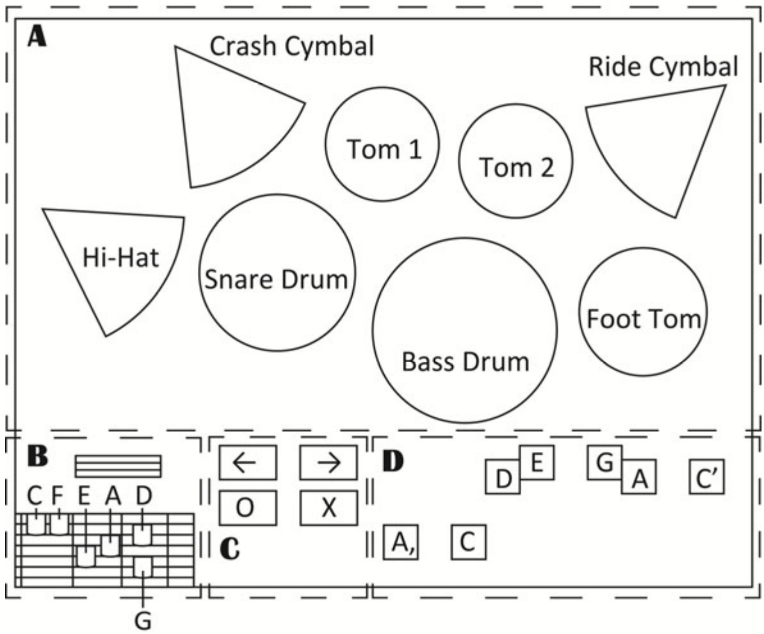

Fig. 9-a. Interaction platform front

b. Side

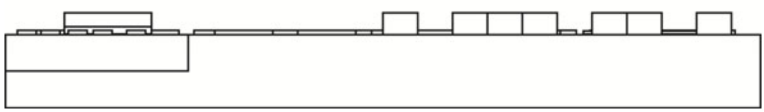

Fig. 9-b. Interaction platform side

c. Height of buttons

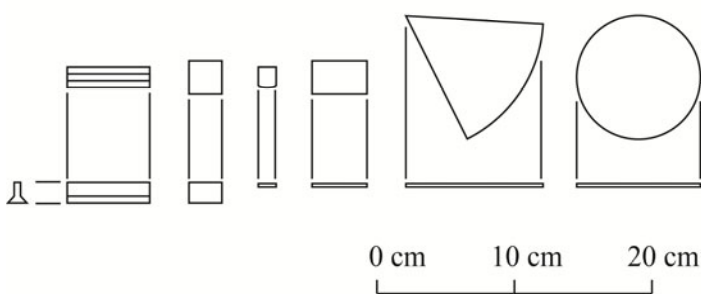

Fig. 9-c. Interaction platform height of buttons

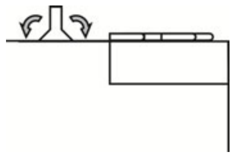

Fig. 10. Pizzicato stick

Fig. 11. Cardan Shaft

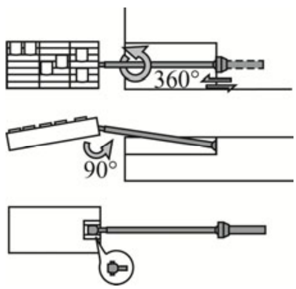

Fig. 12. Guitar fret board connected by Cardan Shaft

4 Conclusion

Improvisation on music composition game provides music learning through improvising rhythms, melody, and chords, the very basic elements of a music composition. Since this composition game can be played repeatedly, it motivates active learning of music knowledge as well as playing techniques on interaction platform, which is normally needed in daily practice of developing internalization of musical sounds.

For pedagogical reason this game is based on Dalcroze's ideas of Eurhythmic and his sequential teaching leading to music composition; writing rhythms, melodies, and chords through improvisation activities. In rhythm improvisation, quarter note, 8th note, and 16th notes are basic duration to create rhythmic patterns. Orff considered that pentatonic melody initiates music learning universally since it exists in many diverse cultures. Particularly, pentatonic scale is assumed to be the fundamental construction of Chinese music and Taiwan-Siao-Diao. For improvisation players, two part writing is an immersive experience, without receiving direct instructions, to realize the elements of constructing triadic chords, as well as the variety of harmonic texture. In advanced stage, this game also provides the player to improvise on triadic chords with more freedom, in the meantime testing player's hearing of consonant/inconsonant triadic chords.

Interaction platform imitates three different instrument contact surface from three different instrumental families: drum set (percussion), piano (keyboard), and guitar (plucking strings). The contact surface of buttons is supposed to give the feeling of playing touches. Besides, hand position and fingering have to cope with the length and width of these virtual instruments. By playing repeatedly, the player is expected to acquire basic performing skills of playing keyboard and guitar, and get familiar with each instrument location of a drum set. This design provides opportunity of combining different music elements as well as hearing experience of different timbre.

Above all, learning by playing (the game and music) is the best way of knowing the true meaning of music theory and composition. The pleasure of improvisation comes from playing a music composition game, not much consuming money but time, for player himself/herself and others to appreciate and enjoying the creation of music. This game playing definitely is not all about music learning.

References

1. Jacques-Dalcroze, E.: Rhythm, Music and Education (Rubinstein, H.F., trans.), vol. 8, pp. 8–45. Chatto & Windus, London (1921)
2. Choksy, L.: Teaching Music in the Twentieth Century. Prentice-Hall, Inc., Englewood Cliff (1986)
3. Campbell, P.S.: Learning to Improvise Music, Improvising to Learn music. In: Solis, G., Nettl, B. (eds.) Musical Improvisation—Art, Education, and Society 2006, pp. 119–142. University of Illinois Press, Urbana (2009)
4. Blacking, J.: How Musical Is Man? University of Washington Press, Seattle (1973)
5. Hall, E.T.: Improvisation as an Acquired, Multilevel Process. Ethnomusicology 36(2), 223–235 (1992)
6. Pressing, J.: Improvisation: Methods and Models. In: Sloboda, J.A. (ed.) Generative Processes in Music: The Psychology of Performance, Improvisation and Composition, pp. 129–178. Oxford University Press, New York (1988)
7. Pressing, J.: Psychological Constraints on Improvisational Expertise and Communication. In: Nettl, B., Russell, M. (eds.) In the Course of Performance: Studies in the World of Musical Communication. University of Chicago Press, Chicago (1998)
8. Brockmann, N.M.: From Sight to Sound—Improvisational Games for Classical Musicians, March 6-8. Indiana University Press, Bloomington (2009)
9. Langer, S.K.: Feeling and Form, p. 121. Charles Scribner's Son, New York (1953)
10. Goodkin, D.: Play, Sing, & Dance—an Introduction to Orff Schulwerk. Schott Music Corporation, Miami (2002)

Increased Game Immersion by Using Live Player-Mapped Avatar Evolution

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Abstract. In ubiquitous game, the interactions between the real world and the virtual world are known and are generally a consequence of the design of a reactive system. This analysis is to lead us to find some basic design essentials to conceive a ubiquitous game with an extended immersion for the user, by combining ideas used in the immersion and avatar theory. In this research, after analyzing all the prior design solutions with respect to their sufficiency in term of immersion, a new method based on the user model is proposed to achieve different degrees of immersion. This theory could be used by designers as the ground to develop the ubiquitous games or ambient entertainment applications.

Keywords: immersion, avatar, ubiquitous game, game design, user model.

1 Introduction

In video games, immersion is a key issue during the different experiences of interaction or narration within the simulated system. From a cognitive perspective, [1] discuss that the gamer's engagement can reach three different degrees: engagement, engrossment, and total immersion. Each degree is reached by removing some barriers to immersion from both the human and the system perspectives. From a gamplay experience perspective, [2] established another method to describe the immersion, SCI-model in three types: sensory, challenge-based, and imaginative. Each type is identified by the player experience during the progress (development) of the game events.

These two definitions for immersion rely on different game mechanisms, either by game interface mechanisms or by the game storytelling engine. In the context of ubiquitous game, we build the definition of immersion on a cognition perspective. The immersive experience in this paper is a concept of presence and defined as the "Extent to which a person's cognitive and perceptual systems are tricked into believing they are somewhere other than their physical location."[3]

This analysis will allow finding some basic design essentials to conceive a ubiquitous game with an extended immersion for the user by combining ideas used in the immersion and avatar theory. The method described in this paper proposes to augment the different aspects of the immersion concept for the player during his gaming experience in ubiquitous game. This theory could be used by designers as the ground to develop the ubiquitous games or ambient entertainment applications.

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2 Related Work

In digital game research, the idea of a player model started from the analysis of player behaviors in Massively Multiplayer Online Role-Playing Games (MMORPGs). User models are classified by social cognitive theory [4], by motivations and psychological experiences of players [5, 6], or by emotional response patterns in game design [7, 8]. These works use the user's states to improve the playability of the game; few works have been found or exploited on the immersion degree correlated to the user model. So our research goal is to produce an immersion principle during the play according to user's different parameters, which turns to be more complicated in the case of ubiquitous games as the user exists both in the real world and in the virtual world.

To create a "real world" ambiguity is to create the game intensity, which depends strongly on the player's immersion i.e. the achievement of "flow" in the game. In ubiquitous games the "real world" environment is important and from the player's perception, it is not replaced by synthetic data from the game universe. So immersing the player is much more difficult in ubiquitous games than in conventional video games. The designer of ubiquitous game thus should consider not only the players physical security but also allow him to continue his ongoing daily activities, and conceive the gameplay to create deliberate ambiguities and map the game universe according to the real world. Therefore, immersion in ubiquitous games is a different level of immersion than immersion in video games. To keep the player deeply involved and interested over a long time span, specific ubiquitous game solutions are needed.

3 User Model

In our context, the game system uses a user model to control the evolution of the avatar. The user model depends on a set of parameters that can be either statically defined by the game designer or dynamically adjusted by the changes in the user's physical states or even the user's social features and personality inside or outside the game course [9]. This leads to three levels of parameters in the user model: general, virtual personalized or physical personalized. The degree of immersion depends upon the level of user model for the avatar (see Fig. 1).

We call a "General User Model" that is a model only based on generic parameters, and that will only lead to engagement in the game. Such games include ludo-educative games and simulation games. For example, a car racing game dedicated for a 4-7 years old Asian child can only have the lowest degree of immersion. The child gamer needs to pay attention, effort and time to engage with the racing game. Time is an essential element for the identification of the player to his avatar. This is why persistent world players such as MMOG players can be more attached to their avatars than turn-based console games players such as Wii or Kinect players, even if the latter use motion sensors for their avatar. In this degree, the attention and the time is the minimum requirement for the player's immersive experiences.

A user model that includes virtual personalized parameters is called a "Virtual Personalized Model". A game with both general and virtual personalized parameters can be found almost in every video game. For example, an action-adventure game could be designed about the oriental knight culture. So the player is not only an occidental young man who knows and respects this knight system to play the game, but also has his avatar presented in this virtual knight society, whose name, profession and skills have only meanings in the virtual world. In this degree, besides attention and time, player needs to invest emotion through his avatar to keep playing the game. His mind and feelings will be influenced by his experiences in the game and even off the game, but his emotional result or other physiological effects will not directly have an impact on the game progress.

A user model that includes at least one physical personalized parameter is called a Physical Personalized Model. There is a complicated mapping between the player's characteristics and his avatar's feature or its evolution. For example, through some captors or smart objects, player’s physic-biological or his physical environment will have an effect on the avatar’s states and thus trigger some game events. In this case, player may consider himself is the game character, and think himself being present and doing something constructive in the game. Not only the game audio-visual presentation and narration fully immerse the player in the virtual universe, but also his physical feature related to his avatar make him feel the "suspension of disbelief" and have empathy with the physical surroundings. In this degree, besides attention, time and emotion, player needs to attach the empathy with the game elements and features both in the real and virtual world. For a ubiquitous game, the time, the space and the social network of the game is extended into the real world. With these extensions, the attention, emotion and empathy invested will be extended too, thus the player may feel more immersed.

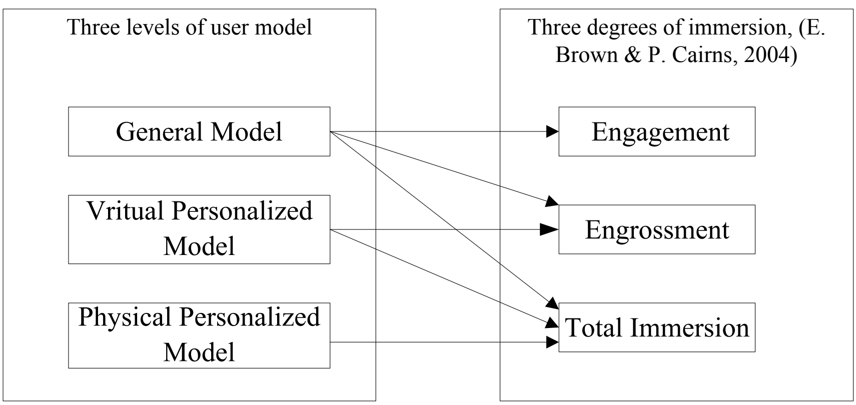

Fig. 1. Relation between the user model and the immersion

Only if the avatar is constituted in three levels of user model, that is to say, the avatar not only has the general and virtual personalized parameters of the user, but also his physical personalized parameters. In this ideal case, the user is identified in the real and virtual worlds at the same time. His physical behaviors or actions will have semantic meanings in the virtual world through his avatar, and the game events or virtual objects will influence his daily physical activities. He is totally immersed in a mixed reality ambiguity. However, for the moment the criteria for successful ubiquitous games are barely known. Ubiquitous game scenarios have to deal with unpredictable individual and social behaviors with simultaneous involvement of the player in several tasks, some in the game, others related to his daily life [10], without interrupting the “flow” from the real world to the virtual world.

Table 1 shows a comparison of different types of applications in this criterion of the user model and the degree of immersion (See Table 1).

Table 1. Analyze of different types of applications with the user model

Level of User Model	**Criterion**	**Type of Avatars**				
		Instant Messaging Avatar	**Video Games Avatar**	**Smart Objects Avatar**	**LBS Mobile Avatar**	**Augmented Reality Avatar**
General User Model	Civil status	√	√	√	√	√
	Social Contact	√	√			
	Preferences		√	√	√	
Virtual Personalized Model	Accounting	√	√		√	
	Avatar Status	√	√	√	√	√
	Avatar Actions		√	√	√	√
	Social Relationship		√		√	
	Virtual Evolution		√	√	√	√
	Deliberate input by user	√	√	√	√	√
Physical Personalized Model	Physical Parameters				√	√
	Geo-Location			√	√	
	Social Relation in Real Life		√		√	
	Virtual Evolution Connected with Daily Activities					
	Non-deliberate input by user					
Examples of Applications		*msn, Skype, yahoo, messenger QQ*	*single player game, MMOG*	*Tamagotchi, Tuttuki bako, Lovegety*	*Mogi, Botfigt2 MYHT, Pocket Critter*	*Eyetoy, Kinect system, Human Pacman*
Degree of Immersion	Engagement	√				
	Engrossment		√	√	√	√
	Total Immersion					

4 Conclusion and Future Works

This research is a game design theory research. This paper proposes a model of possible relationship between different degrees of immersion and different levels of user model for the avatar. This will not only help us understand and to analyze a large variety of interactive multimedia applications, but also could be considered as the design principles for conceiving ubiquitous games.

These findings on avatar and immersion offer many open problems for further research, in particular, the augmentation of "real world" ambiguity in ubiquitous games. We believe that the work should be focused on the most important and complex game ingredient: the player himself and his avatar. So how to permanently match semantic attributes of the "real world" player characteristics and non-deliberate behaviors to his game character representation and to evaluate this theory with a multiplayer ubiquitous game will be the next step in our research. According to the level of the ability to manage the avatar evolution in form of user model, and depending on various aspects of the game system (technical complexity, social and environmental contexts, privacy constraints), this method may be used in several ways. Future works also include an implementation of these design principles in our ongoing projects of location-based mobile games.

References

1. Brown, E., Cairns, P.A.: A grounded investigation of game immersion. In: CHI Extended Abstracts 2004, pp. 1297–1300 (2004)
2. Ermi, L., Mäyrä, F.: Fundamental Components of the Gameplay Experience: Analysing Immersion. In: Changing Views: Worlds in Play, selected Papers of the 2005 Digital Games Research Association's Second International Conference, Vancouver, pp.15–27 (2005)
3. Patrick, E., Cosgrove, D., Slavkovic, A., Rode, J.A., Verratti, T., Chiselko, G.: Using a Large Projection screen as an Alternative to Head-Mounted Displays for Virtual Environments. CHI Letters 2(1), 478–485 (2000)
4. Stora, M.: Guérir par le virtuel: une nouvelle approche thérapeutique. Presses de la renaissance, coll. Société, Janvier (2006)
5. Hopson, J.: Behavioral Game Design. In: Proc of GDC 2004, San Jose CA (March 2004)
6. Yee, N.: Motivations of Play in MMORPGs: Results from a Factor Analytic Approach. The Daedalus Project (2005), `http://www.nickyee.com/daedalus/motivations.pdf`
7. Calica, B.: The Rules of the Game: I Second that Emotion. In: Gamasutra (June 1998)
8. Freeman, D.: Four Ways to Use Symbols to Add Emotional Depth to Games. In: Gamasutra (June 2002)
9. Natkin, S., Yan, C.: User Model in Multiplayer Mixed Reality Entertainment Applications. In: Proceeding of ACE 2006, ACM SIGCHI, Hollywood, USA (June 14-16, 2006)
10. Tamminen, S., Oulasvirta, A., Toiskallio, K., Kankainen, A.: Understanding mobile contexts. In: Proc. Mobile HCI 2003. LNCS, pp. 17–31. Springer, Heidelberg (2003)

My-Bookstore: A Game-Based Follow-Up Activity to Support Modeled Sustained Silent Reading

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Abstract. Modeled Sustained Silent Reading (MSSR) is one of significant approaches for pupils to developing early literacy. This study proposes a game-based follow-up activity to support the MSSR activity: My-Bookstore. My-Bookstore includes two phases, *reading recording* and *book recommendation*. Students note down their reading status and recommend the books without any compulsion. The aim of this study is to promote student's reading interest by opinions sharing and discussion through a game-based social interaction environment.

Keywords: Game-based learning, modeled sustained silent reading, management game

1 Introduction

Reading is regarded as a significant way to develop early literacy (Gardiner, 2005), especially for pupils. This is due to the fact that reading not only could foster pupils' capability of recognizing symbolic representation and meaning-making, but also the ability of learning how to learn. Because of the significance, different approaches were proposed to promote the reading activity. One of significant approaches is Modeled Sustained Silent Reading (MSSR), which emphasizes that students of a class or a school read quietly during class times (Atwell, 2007). The SSR is often supported by different follow-up activities after the reading phase (Pilgreen, 2000). These follow-up activities are essentially different from traditional responsible reading reports. Instead, they provide an outlet for sharing reading enthusiasm with others (Atwell, 2007). Students are often voluntary to join and engage in exchanging opinions. These follow-up activities can be implemented in various ways, such as book talk, discussion, or even dramas.

The purpose of this study is to develop a SSR follow-up activity based on the game-based learning environment, especially in the form of a management game: My-Bookstore. More specifically, a student acts as a manager to run his/her bookstore, including recording what he/she had read and recommending the books he/she likes to their classmates. The details would be introduced in the following sections.

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2 My-Bookstore System

The designed SSR follow-up activity includes two main phases, reading recording and book recommending. After the SSR phases, students log in to the system named Reading Recorder to take down the books they read as foundation data of learning portfolios. And then, students go into a management game, named Book Manager for book recommendation.

First, students log into the Reading Recorder (Figure 2) to taken down what they read in the SSR phase. Students not only note down the name of the book in the Reading Recorder, but also note their reading status. System would ask some questions, such as "Have you read all the paragraphs in this book?" for teachers to understand each students reading status. The main purpose of the Reading Recorder is to help teachers to understand each student's reading predilection more easily. Thus teachers can provide more adaptive suggestions for students to enjoy reading.

The second subsystem is Book Manager (Figure 3). Book Manager is a social interaction game. In this game, every student acts a book store manager. Student can earn virtual coins by recommending book to his classmates. Student recommends book by drawing, sound recording and typewriting. Students can visit each other's book stores and order the virtual books from book stores. If certain student accepts the recommending from the book store and then also read this book in the next SSR phase, the book store manager will get the coins. Student can pay some coins for adornments to make his book store different from others'.

Fig. 2. The Reading Recorder

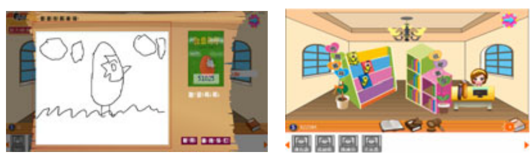

Fig. 3. The Book Manager

3 Future Work

This study proposed a game-based SSR follow-up activity, My-Bookstore. In this activity, students note down their reading status and recommend the books that they had read without any compulsion. Different from the traditional reading reports, students get reading interest from sharing opinions and social interaction. The future work of this study will focus on the detail analysis of students' behaviors.

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References

1. Atwell, N.: The reading zone. Scholastic, New York (2007)
2. Gardiner, S.: Building student literacy through sustained silent reading. Association for Supervision and Curriculum Development Alexandria, Virginia (2005)
3. Pilgreen, J.L.: The SSR handbook: how to organize and manage a sustained silent reading program. Boyton/Cook Publishers, Portsmouth (2000)

Way to Inspire the Museum Audiences to Learn: Development of the Interpretative Interactive Installations for Chinese Cultural Heritage

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Abstract. There are more and more technologies applied to cultural heritage. Especially, the educational multimedia technology is usually adopted to support the education purpose in museum sector. To find a new way for development the edutainment media, the research team considered the different characters of target historical objects of National Palace Museum, and develops "the prototype interpretive interactive installations", including Context-aware System, Interactive Tabletop System, Virtual Display System and Virtual Panel System, to make the systems open for the audience, called "pilot project". According to the feedback from the audience, the team modified the original design and enhanced the aesthetic elements of the installation to develop further "Practical Models" which are helpful for displaying museum collections and visitors' learning experiences. This article aims to develop the interactive learning applications that advance the interpretations and enhance visitors' learning experiences.

Keywords: Cultural Heritage, Interactive Tabletop System, Virtual Display System, Virtual Panel System.

1 Introduction

The National Palace Museum (NPM) established in 1925 houses more than 680,000 objects in collections and is considered as one of the world-leading museums. To share the invaluable cultural heritage to people around the world, the research team is grouped by inter-disciplinary members and has always sought to make its collections accessible to greater and diverse audiences. The American Association of Museums (AAM) has defined that "Interpretive Interactive Installations are made up of multiple kiosks or a full gallery installation and are interactive and educational" [1]. The interpretive installations are a kind of computer-supported system designed to provoke conversations between museum contents and visitor. This article aims to develop the advanced non-laboratory-based computer-supported system and enhance visitors' learning experiences in the museum. The research team started with the pilot project called "Treasures Transformers" [2]. Through the "Treasures Transformers", four HCI interpretative installations were developed and used to accommodate

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different natures of collections. These four installations include *Ladies, People are Coming*; *Livening up Paintings on the Tabletop*; *Magic Crystal Ball*; and *Animals of Fantasy*. Next, Mini-survey, semi-structured interviews and observations were conducted to evaluate the prototype model systems. Hence, the assessment results work as an important basis for developing practical model system. The team consider that aesthetic elements are essential to historical art museums. Consequently, aesthetic expressions became one of the main design principles. The three-step evolution from prototype model to practical model system is shown as Fig. 1. The major exhibition gallery is at the NPM Future Museum in the Terminal 2 of the Taiwan Taoyuan International Airport (see Fig. 2).

Fig. 1. The three-phase system development

Fig. 2. The outlook of the NPM Future Museum in the Terminal 2 of the Taiwan Taoyuan International Airport

2 Design Principles

Based on experience for years on museum multimedia development, the team has defined four criteria as design principles in the prototype model developing phase: Novelty, Accessibility, Reliability and Learning potential[2]. In practical model developing phase, the aesthetic issues are integrated into the implementing.

Novelty. To vivid visitors' museum experiences, more and more media are applied in museums, such as text panels, brochures, films, audio guide, standard touch-screen and so on. However, as people live in the modern information society, the traditional interpretation devices can not satisfy diverse museum visitors any more.

Accessibility. Museums are generally considered as a public space and welcome visitors with diverse background in age, language, education or occupation. Hence, the “Accessibility” is essential in developing interpretive interactive installations.

Reliability. The IEEE defines that, “Reliability is the ability of a system or component to perform its required functions under stated conditions for a specified period of time” [3]. Owing to the final objective to construct a non-laboratory based system, Reliability is indispensable to visitors and system keepers.

Learning Potential. According the definition of International Council of Museum (ICOM), museums have the duty to stress their educational function to the public [4]. However, visitors are totally diverse so that museums need to meet everyone’s learning style which is a challengeable issue for museum practitioners. To enhance visitors’ learning desire, the design of interpretive installations needs to be more attractive to arouse curiosity of people, promote the nature of artifacts, and build up aesthetic learning environments.

Aesthetic. One of the purposes of visiting museums is being immersed in artistic atmosphere [5]. In addition to applying innovative technologies to interpret historical objects and to enhance interactions between people and computer-supported systems, the research also aims to create more artistic interactive scenarios and installation appearance with design features which can provide ways of enjoying artistic atmosphere to visitors.

3 Evaluations

As mentioned, the pilot project that the team worked on was the first step to construct prototype systems. To develop the further system, the team evaluated the prototype model systems based on four design principles, “Novelty”, “Accessibility”, “Reliability”, and “Learning Potential”. During the “Treasure transformer” exhibition, the survey was undertaken to the pilot project. The results can be summarized in the Table 1[2]. Then, the research team adopted the results and response them to the design of practical model.

4 System Implementation

4.1 Context-Aware System: *A T’ang Palace Rhapsody*

To exhibit this installation in the NPM-Future Museum in Taoyuan International Airport of Taiwan, the team added the function of checking international time in the scenario to respond to visitors’ travel experiences. Adapted from the painting, “A T’ang Palace Concert”, describing several Ladies of T’ang Dynasty chatting with ease and playing musical instruments in the afternoon tea time, the design also tries to make people feel and be immersed in a happy atmosphere in form of new media.

Table 1. Executive findings of the evaluation, N=92 respondents

Indicators	*Ladies, People are coming*	*Livening up Paintings on the Tabletop*	*Magic Crystal Ball*	*Animals of Fantasy*
Novelty Ranking	12.4% 4	36.0% 1	34.8% 2	16.9% 3
Accessibility Ranking	Mean=4.05 3	Mean=4.39 1	Mean=4.13 2	Mean=3.97 4
Reliability Ranking	13.0% 3	47.8% 1	29.3% 2	9.8% 4
Learning Potential Ranking	17.4% 3	30.4% 2	49.3% 1	2.9% 4
Overall Effectiveness Ranking	3	1	2	4

Hardware Configuration. To improve the audience's visiting experiences, the team transformed *Ladies, people are coming* into *A T'ang Palace Rhapsody*. The later installation is composed by multimedia display module and location-aware module, including the primary display screen, three second display areas. Furthermore, the pressure-sensing pads are arranged to sense locations of visitors. The main structure is shown as Fig. 3a.

Content Scenario. The scenario of this piece is described as the following step:

Step 1: While people are away from the installation, Ladies of T'ang Dynasty are chatting casually. The Fig. 3b depicts the initial condition.

Step 2: Once Ladies of T'ang Dynasty find that somebody's coming, the animation will be back to the original painting. At that time, people can enjoy the beauty of the ancient painting.

Step 3: Visitors can choose to step on different projection images on the ground, including Taiwan, New York and Paris, to check time of Taiwan, New York or Paris. The step is shown on Fig. 3c.

Step 4 (Paris time-zone state): If a visitor chooses Paris, visitors will see the time of Paris on the primary screen and hear some beautiful French chansons around them.

Fig. 3. (a)The major components of the installation are the primary display screen, the secondly display areas and the pressure-sensing pads. (b) The animation presents ladies of T'ang dynasty lively chatting in the afternoon teatime. (c) A user is selecting the Paris time zone scenario by standing on the pressure-sensing pad with the images of Paris.

Step 5 (Taiwanese time-zone state): When a visitor chooses Taiwanese time-zone, the primary screen will immediately show the time, and Ladies of T'ang Dynasty will be using famous Taiwanese 3C products such as mobile phone, notebook computer and cameras.

Step 6(New York time-zone state): Once the visitor chooses the New York, the time and images of Free Goddess will be shown on the screen.

4.2 Interactive Tabletop System: *Livening Up Painting on the Tabletop*

Through the installation, users can enjoy details of historical collections in a natural interactive way. In the installation, users can explore the diversity of ancient Chinese paintings and calligraphy artworks. At first, users navigate what they'd like to know. Secondly, users can browse their details through the Fovea projection area (see Fig. 4a). The outlook of the tabletop was inspired by traditional Chinese art (see Fig. 4b). The hardware architecture had mentioned at the previous work of our research team [6].

4.3 Interactive Virtual Display: *Magic Crystal Ball*

In the ancient legends, the crystal ball is always considered as a magic medium for fortune telling. Consequently, the research team turned the crystal ball into the best interface for appreciating 3D shapes of ancient historical objects. The hardware architecture had mentioned at the previous work of our research team [7].

Fig. 4. (a) A user is interacting with the multi-touch multi-resolution tabletop to browse the details of the peacock painting. (b) The design of the tabletop was inspired by traditional Chinese art.

Content Scenario. The 3D panorama image of the historical object is displayed in the ball-shaped screen. Users are allowed to touch the screen to turn upside down the 3D virtual image of the object as they want (see Fig. 5).

Aesthetic Expressions. In the scenario of the installation, visitors can find the beautiful images of the five famous ancient artifacts of the National Palace Museum. To respond to the characteristics of selected collections, the veins of the "Ivory Ball" of Qing Dynasty were used on the surface of *Magic Crystal Ball* with five LED buttons representing five ancient artifacts. It also employed the lighting effect through the openwork carving to express the different spirit of each artifact (see Fig. 6).

Fig. 5. A little girl is manipulating the 3D images on the *Magic Crystal Ball*

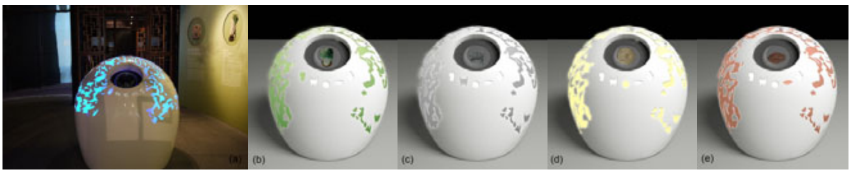

Fig. 6. The appearance of the *Magic Crystal Ball* was inspired by "Ivory ball" of NPM. It can also display correspondent LED lights of which the ancient artifacts being chosen.

4.4 Virtual Panel System: *Jumping over the Dragon Gate*

According to the assessment results, *Animals of Fantasy* received three lowest ranking among four indexes. Therefore, interactive scenario and hardware structure is changed dramatically.

Hardware Configuration. The installation is formed by an immersive display module and three virtual panel modules (see Fig. 7a). The structure of the virtual panel includes Fresnel lens, LCD monitor forming display module and a detection module of hand gesture recognition (see Fig. 7b).

Content Scenario. "Jumping over the Dragon Gate" comes from an old Chinese idiom. It illustrates the image of fish struggling to leap the fast and turbulent stream at a place called "Dragon Gate". Now it is represented as an interesting interactive installation which is similar to a kind of sportive game. While visitors are away, the scenario shows the image of the ancient painting of Ming Dynasty, "Fish and Water Plaints" on the screen. Once a visitor comes close and steps into the detecting area, the system reacts and changes to interaction states. Fish in the paining are at first swimming slowly on the primary display screen and then they jump out of the three virtual panel and swim in the air. The user is allowed to virtually touch and catch fishes in the air (see Fig. 8a). Once the user catches fishes successfully in the limited time, the system notifies visitors with images of water waves and sounds of water (see Fig. 8b).

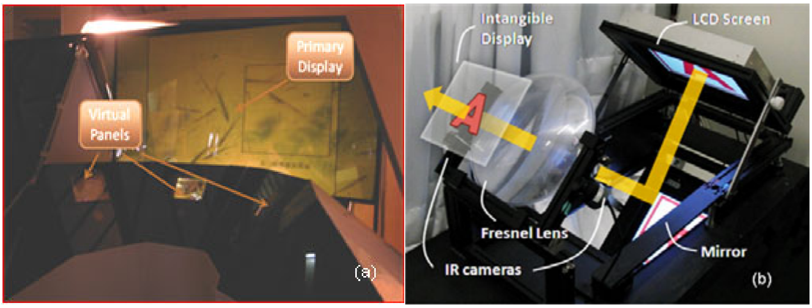

Fig. 7. (a)The key components of the installation are the primary display module and the Virtual Panels module. (b) The structure of Virtual Panel: The images are firstly generated by the LCD screen, and are then reflected by the mirror, and finally appear in front of the user through the Fresnel lens [8].

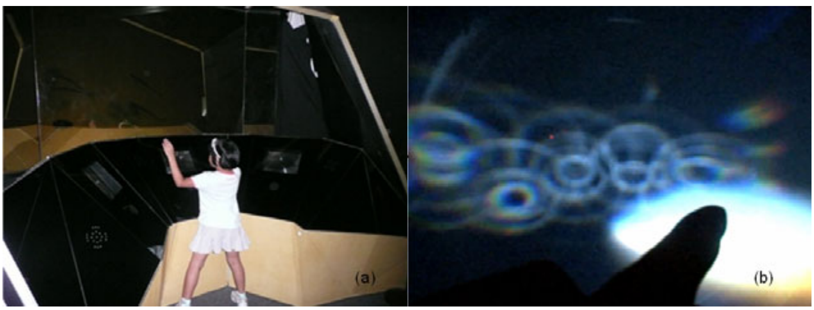

Fig. 8. (a) A user is interacting with the installation in the sensing area. (b)When the user touches the virtual image on the intangible display area, the “water” will ripple as a visual feedback to the user.

5 Discussions and Conclusions

In this research, we not only aim to develop the interesting and artistic computer-supported system, but also attempt to inspire the audience’s learning desire of cultural heritage of National Palace museum. According to the team’s research process, observations on visitors’ operating experiences and the audience interviews, the team found that, in the pilot project, the top three installations of the evaluation result did help animate visitors’ learning experiences and promote information of museum collections. Ameliorated from the prototype model system, practical model system brings better experience in which visitors can interact with installations with their own body in an aesthetic environment. The best example is the transformation of *Animals of Fantasy* into *Jumping over the Dragon Gate*. Moreover, when the aesthetic design is integrated into the interactive installations, they are more popular to visitors. The significant improvements example is *A T’ang Palace Rhapsody.* Finally, the interactive learning applications effectively inspire the audience’s curiosity of museum and enhance the learning experience.

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References

1. Interpretive Interactive Installations definition: The AAM media and technology committee websites, `http://www.mediaandtechnology.org/muse/criteria.html`
2. Hsieh, et al.: Treasure Transformers: Novel Interpretative Interactive Installations for the National Palace Museum. In: Proceedings of the International Conference of Art & Technology (2009)
3. Reliability definition: The Wikipedia website, `http://en.wikipedia.org/wiki/Reliability`
4. Museum definition: The ICOM websites, `http://icom.museum/who-we-are/the- vision/museum-definition.html`
5. Aoki, P.M., Woodruff, A.: Improving Electronic Guidebook Interfaces Using a Task-Oriented Design Approach. In: Proc. 3rd ACM Conf. on Designing Interactive Sys., New York, pp. 319–325 (August 2000)
6. Hu, T.T., Chia, Y.W., Chan, L.W., Hung, Y.P., Hsu, J.: i-m-Top: An Interactive Multi-Resolution Tabletop System Accommodating to Multi-Resolution Human Vision. In: Proceedings of the IEEE International Workshop on Tabletops and Interactive Surfaces (2008)
7. Chan, L.W., Chuang, Y.F., Yu, M.C., Chao, Y.L., Lee, M.S., Hung, Y.P., Hsu, J.: Gesture-based Interaction for a Magic Crystal Ball. In: Proceedings of the 14th International Conference on ACM Virtual Reality Software and Technology (2007)
8. Chan, L.W., Hu, T.T., Hung, Y.P., Hsu, J.: On Top of Tabletop: a Virtual Touch Panel Display. In: Proceedings of the IEEE International Workshop on Tabletops and Interactive Surfaces, Amsterdam, Netherlands (2008)

Learning from Internet of Things for Improving Environmentally Responsible Behavior

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Abstract. We present two designs in the area of Internet of Things, utilizing an ontology-driven platform, namely Smart-M3, to connect domestic objects in the physical world to the information world, for coaching the behavior or raising the awareness in domestic energy consumption. The concept and architecture of Smart-M3 are introduced, in which the domestic objects are knowledge processors connected to the semantic information broker that contains the ontologies, using a blackboard design pattern and semantic web technologies, enabling the interoperability among both digital and physical entities. Two designs based on Smart-M3 are presented, as examples for coaching with and learning from the Internet of Things. Although both designs are in the area of domestic energy consumption, they can be seen as good starting points towards broader areas of ubiquitous learning with the Internet of Things.

Keywords: Internet of Things, ontology, semantic web, ubiquitous learning.

1 Introduction

The environments that people inhabit are occupied with a growing number of digital and networked devices. We have not yet succeeded in seamlessly operating among these devices. Especially when we consider the way user interaction was envisioned in paradigms like Ambient Intelligence [1], Pervasive Computing, Ubiquitous Computing [10] and the more recent notion of Internet of Things [8]. One of the key goals of these paradigms is “serendipitous interoperability”, where devices which were not necessarily designed to work together (e.g. built for different purposes by different manufacturers at different times) should be able to discover each other’s functionality and be able to make use of it [9].

One solution to solving the interoperability problem at the infra-structure level is a software platform developed within the SOFIA project[1]. SOFIA (Smart Objects For Intelligent Applications) is a European research project within the ARTEMIS framework that attempts to make information in the physical world available for smart services – connecting the physical world with the information world. Rather than promoting the compatibility within one specific service-level solution in terms of

[1] www.sofia-project.eu

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protocols or software stacks, it addresses information-level compatibility and the collaboration between different producers and consumers of information on a more abstract level. It does not add, nor require an additional single service-level infrastructure or middleware that all manufacturers must adopt, but builds on what is already available in the industry.

The Internet of Things is often referred to as a network of RFID tagged everyday objects. In the context of SOFIA, the Internet of Things is much more. It is a network of smart objects which each have (from very limited to extensive) computational power and connectivity. These smart objects form are from the "internet", in an environment or across environments, which makes it close to the concept of ubiquitous computing, and creates new possibilities for innovative applications.

In this paper we present two designs that utilize these new possibilities, for coaching the behavior or raising the awareness in domestic energy consumption. A study by Burgess et al [2] indicates that of all the energy that people consume, 30% is consumed in a domestic setting. Furthermore it states that, roughly 30% of domestic energy consumption which can be attributed to behavioral choices. By stimulating more Environmentally Responsible Behavior (ERB), the consumption can be reduced by up to 10%. Instead of actively and explicitly teaching and coaching, the stimuli and advices are woven into everyday objects that are connected to the energy consumption information, for people to learn from the Internet of Things to stimulate their ERB.

Next the basic structure and concept of SOFIA platform are explained, followed by two design cases. Each case is presented with the design concept and prototype, as well as the feedback collected from the user evaluations.

2 SOFIA Smart-M3

The SOFIA software platform utilizes the blackboard architectural pattern to share information between smart devices, rather than have the devices explicitly send messages to one another. When this information is also stored according to some ontological representation, it becomes possible to share information between devices that do not share the same representation model, using the semantics of that information [5].

Ontologies are used to enable the exchange of information without requiring up-front standardization. The first core component of the SOFIA platform is called Smart-M3 and an open source implementation is available online[2]. A notable feature of the SOFIA platform is the capability to subscribe to changes of data (stored as triples) in the data store, and be notified every time these triples are updated, added or removed.

Smart-M3 takes the blackboard and publish/subscribe concepts and implements them in a lightweight manner suitable for small, mobile devices. These devices (Knowledge Processors or KPs), can operate autonomously and anonymously by sharing information through an information store. The Semantic Information Broker (SIB) is the information store of the smart space, and contains the blackboard,

[2] Available from http://sourceforge.net/projects/smart-m3/

ontologies and required service interfaces for the KPs. Fig. 1 shows a simplified overview of the Smart-M3 infrastructure.

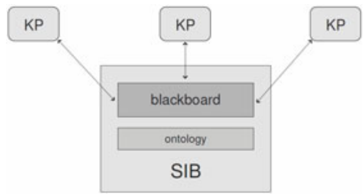

Fig. 1. SOFIA infrastructure model

For applications, a Description Logic (DL) based ontology can be created in OWL, the Web Ontology Language [9]. In the current ontology all user interaction within the system is described in terms of interaction events [4]. To enable our semantic connections interaction model (introduced in more detail after this section), the connections between the devices need to be modeled. A connectedTo relationship can be added or removed between two existing devices in the ontology. It should be noted that this relationship is both symmetric and irreflexive. A symmetric property is its own inverse, which means that if we indicate a connectedTo relationship from device A to device B, device B will also have a connectedTo relationship to device A. Another way to think of symmetric properties is that they are bidirectional relationships. An irreflexive property is a property that never relates an individual to itself. This allows us to restrict our model by not allowing a connectedTo relationship from a device to itself. In our application to energy streams, other properties such as transitivity and additivity can be added: if device A has access to energy from B and B can take energy from C then indirectly A has access to energy from C (transitivity). For a node which is neither a source nor a sink, the sum of the incoming energy flows equals the sum of the outgoing energy flow (additivity).

In this structure, to determine which other smart objects a specific device with a deviceID is connected to, a simple SPARQL query suffices:

```
select distinct ?object where {
   deviceID semcon:connectedTo ?object }
```

To get the last event belonging to a specific device, for example the event triggered by Near Field Communication (NFC) when the device comes close to the other, the SPARQL query is a little bit more complex, but still surprisingly manageable (see [4] for more details):

```
select ?position ?eventType where {
   deviceID semcon:hasRFIDTag ?tag .
   ?event semcon:hasRFIDTag ?tag .
   ?event semcon:hasPosition ?position .
   ?event a ?eventType .
   ?event semcon:inXSDDateTime ?time .
   FILTER (
      ?eventType = semcon:NFCEnterEvent ||
      ?eventType = semcon:NFCExitEvent) }
   ORDER BY DESC (?time) }
```

At a more conceptual level the term “semantic connections” is used in the SOFIA project, referring to meaningful connections and relationships between entities of the Internet of Things [6, 7]. Semantic connections exist in both the physical and the digital world. They have informative properties, i.e. they are perceivable in the physical world and have sensory qualities that inform users about their uses. However, these physical qualities might be hidden at some times, or only accessed on-demand, by a special purpose interaction device. The digital counterparts of semantic connections are modeled in an ontology. There may be very direct mappings, e.g. a connection between two real-world entities may be modeled by a connectedTo relationship between the representations of these entities in an ontology.

3 Design Cases

Based on the concepts from SOFIA and Smart-M3, two products are designed in the application area of stimulating people to improve their ERB in domestic environments, i.e, their home environments. These environments are conceptually smart spaces enabled by SOFIA smart objects. Energy consuming appliances in these environments are KP-enabled objects that are connected to the SIB hence they are interconnected, providing energy consumption status and history to the SIB and accepting and reacting on queries, events and commands from the SIB.

3.1 Doormate

Concept. The Doormate is first of all a doormat for wiping your feet, but also a coaching mate supporting lowering of electricity consumption [11]. It does the latter by communicating information through an integrated low resolution LED display (Fig. 2). The Doormate gathers data from the smart appliances in the home, such as time of use, frequency of use, intensity of the appliance during use and duration of use. By combining this data and evaluating changes, information on improving usage behavior can follow. It allows people to easily turn of devices when leaving the house as well as improving their energy consumption behavior by learning from tailored coaching when returning home.

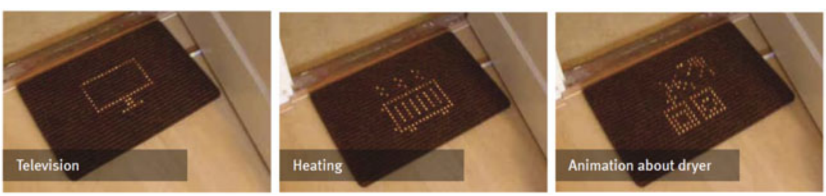

Fig. 2. Doormate integrated with a low resolution LED display

Fig. 3 illustrates the interface. To switch off the depicted device the user steps with one foot on the lit up power icon (top left) and with the other foot applies pressure on the display, as if putting out a cigarette. If more devices are available to be switched off, the arrows will light up and can be used to scroll through the icons. When entering the house the user can spend a moment to learn (or get a cue to remember) how certain behavior can be changed to be more energy efficient. As the contact time between product and user is longer, animations are used to explain the coaching tips. If the user does not understand the animation, he or she can get more information later on his/her smart phone or laptop by both pressing the lit up coaching icon (top right) as well as the display. In the case of the coaching state the user is able to 'flip' through tips if more are advised.

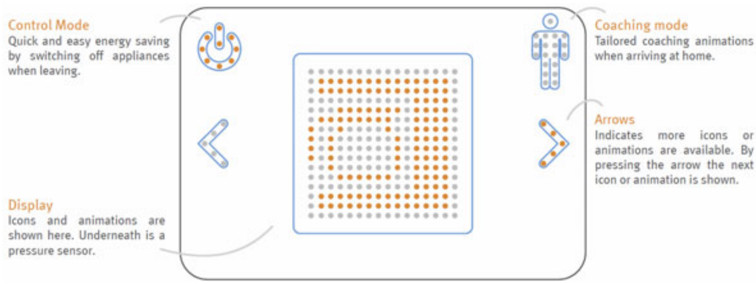

Fig. 3. Doormate Interface

Fig. 4 shows two use case scenarios. The top scenario shows how a user forgot to switch of the lights and is reminded by the Doormate. He then decides to switch them off using the Doormate. The bottom scenario shows how a person who is coming home is detected and, while he is taking off his coat, is shown an animation on how to be more electricity efficient. If he does not understand it immediately, he can press the Doormate to receive more information on his smart phone.

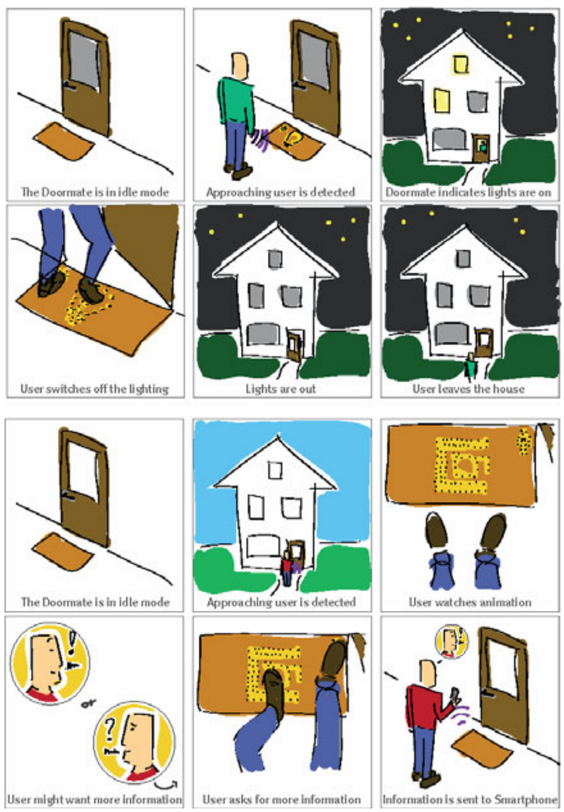

Fig. 4. Doormate scenarios

Evaluation. Preliminary tests were done with seven participants. The prototype was used to test three aspects: visibility and general understanding, animation and icon interpretation, and preference in initial coaching display. The effect of the light coming from a doormat, which is generally a very uninteresting and low value object, surprised them and gave the mat more value.

All participants were enthusiastic about the control functionality, as they all recognized the situation where they forgot to turn off appliances. The results and reactions on the Doormate are promising. People recognize the benefits and see themselves using the Doormate over a longer period of time.

3.2 Bonsai Garden

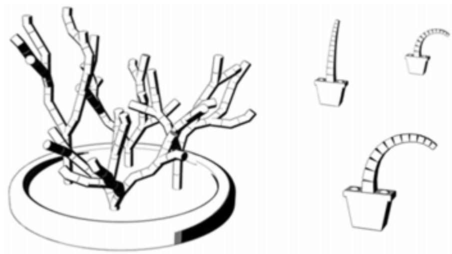

Fig. 5. Bonsai Garden

Concept. The product consists of local feedback devices and a central feedback device. The local feedback devices give direct feedback to the user on their consumption and the central feedback device gives overall feedback on ERB of the different people in a household. The overall feedback is represented by a tree and the trees are placed together in a "bonsai garden" (Fig. 5). These trees consist of building blocks and each individual user can construct their personal tree in any way they want. There are three different kinds of building blocks (straight, angled and split pieces) and they provide endless building possibilities. The amount of building blocks and thus the size of the tree represents the user's personal effort on reducing resource consumption. The user can earn building blocks with good ERB and direct feedback on ERB is given by the local feedback devices (triggers). These triggers show when the user earns points for ERB by changing shape and standing upright. These points are represented by lights in the building blocks for that person's tree. When all building blocks are lit up, the user can add a piece to it.

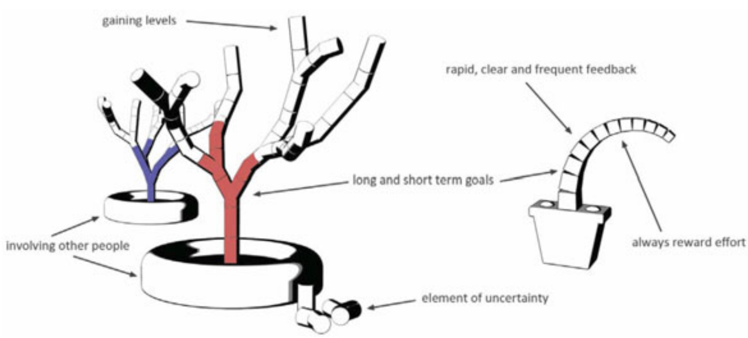

Fig. 6. Gaming elements in Bonsai Garden

The target group of this design is families with young children (8 - 12 years old). The involvement of the entire family adds to the social aspect of motivation. The design contains game elements, derived from on the work of Chatfield [3]. These elements were implemented in this project to create motivation for ERB (Fig. 6): 1) gaining levels: the size of the tree represents the level of good ERB from a person; 2) long and short term goals: The trigger is short-term, the tree represent a long-term goal; 3) always reward effort: users get rewarded for trying to behave well; 4) rapid, clear and frequent feedback: a trigger responds to each resource consuming event; 5) an element of uncertainty: users do not know what kind of building block they will get next; 6) Involving other people: users can compare their trees and compete for the best building results.

Evaluation. The prototype was used to test two aspects: motivation through competition, and motivation through personalization. The evaluation was done with five children from the target user group (Fig. 7). These children were all Dutch and either in the final years of primary or the first years of secondary school. The evaluation was performed in a home situation and the results were recorded with a camera and by taking notes of events and comments. The evaluation was performed with a prototype of the tree that allowed the participants to build a tree out of building blocks. This prototype consisted of a base unit and 30 building blocks, which allowed for complete freedom to build a unique tree.

Fig. 7. Children build their bonsai trees

The test started with an introduction to the design and how the participants could build their own tree later in the test. The competition element was evaluated by having each participant build their own tree and compare them in the final discussion. The next step was a questionnaire about ways to improve ERB. Each right answer would result in a point, and for each point a participant would get two building blocks to build a tree with. In the discussion the nicest tree would be chosen by voting.

The results show that building the trees was a fun experience for all the children. It was a social process, where they advised and commented on each other's trees. Every participant tried to make their tree unique and as different from the others as possible. The prospect of earning building blocks and building their own tree was a big motivation for the children and they were very concentrated on thinking of ways to improve ERB.

4 Concluding Remarks

The SOFIA Smart-M3 platform enables the possibility to embed intelligence into everyday objects and allows these objects to connect to each other and to information entities and services, bridging different products and services from different manufactures and providers. Two products are designed based on the concepts from this platform for improving people's ERB in energy consumption in domestic home environments, implementing different learning strategies. The Doormate provides the convenience of controlling the house appliances at the same time provide behavior coaching, while the Bonsai Garden tries to raise the awareness by employing gaming elements in the design. Although the Internet of Things is limited in one environment, the idea of providing ubiquitous learning with smart daily objects seems to be promising. In addition to smart home environments, in the SOFIA project we are also experimenting with different scenarios such as personal spaces and smart city. The technology can be applied for ubiquitous learning to a broader extent.

References

1. Aarts, E., Marzano, S.: The New Everyday: Views on Ambient Intelligence. 010 Publishers, Rotterdam, The Netherlands (2003)
2. Burgess, J., Nye, M.: Re-materialising energy use through transparent monitoring systems. Energy Policy 36(12), 4454–4459 (2008)
3. Chatfield, T.: Fun Inc.: Why games are the 21st Century's most serious business. Virgin Books (2010)
4. Niezen, G., van der Vlist, B., Hu, J., Feijs, L.: From events to goals: Supporting semantic interaction in smart environments. In: 2010 IEEE Symposium on Computers and Communications (ISCC), pp. 1029–1034 (22-25, 2010)
5. Oliver, I., Honkola, J.: Personal semantic web through a space based computing environment. In: Second IEEE International Conference on Semantic Computing, Middleware for the Semantic Web, Santa Clara, CA, USA (August 2008), `http://arxiv.org/pdf/0808.1455`
6. van der Vlist, B., Niezen, G., Hu, J., Feijs, L.: Design semantics of connections in a smart home environment. In: Design and Semantics of Form and Movement (DeSForM 2010), Lucerne, Switzerland, pp. 48–56 (2010)
7. van der Vlist, B., Niezen, G., Hu, J., Feijs, L.: Semantic connections: Exploring and manipulating connections in smart spaces. In: 2010 IEEE Symposium on Computers and Communications (ISCC), pp. 1–4. IEEE, Riccione (2010)
8. Van Kranenburg, R., Dodson, S.: The Internet of Things: A critique of ambient technology and the all-seeing network of RFID. Institute of Network Cultures (2008)
9. W3C: OWL Web Ontology Language Use Cases and Requirements (2004), `http://www.w3.org/TR/webont-req/`
10. Weiser, M.: The computer for the 21st century. Scientific American (September 1991)
11. Willems, D.: The doormate: Supporting people in decreasing their electricity consumption. M11 report, Theme Realities, Department of Industrial Design. Eindhoven University of Technology, Edinhoven (2011)

Using Intelligent 3D Animated Character as the Interface for Interactive Digital TV System

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Abstract. In this research, we propose to incorporate intelligent 3D character into interface design to enhance the user experience on the interactive digital TV system. Based on the smart interactive digital TV system, call SITV, developed in our previous work, we consider several interactive scenarios in the design of the intelligent 3D animated character. We propose to design our intelligent 3D character with the concepts of mobility and expressiveness on body motion such that appropriate emotions can be presented according to TV watching scenarios and character configurations. We have designed experiments to evaluate different types of user interface design for various scenarios. We have found that although the interface with animated character can attract the attention of the user and enhance interactivity, the text-based dialog box interface is still the easiest to understand. We also have found that when the freshness of the new interface with animated character decays after some time of use, it is crucial for an animated character to have expressive motions.

Keywords: Interactive TV, Animated Character, Emotion, User Interface.

1 Introduction

With the emergence of digital TV, the interaction between TV and the audience is becoming richer [4]. In an ideal interactive TV, the audience can not only passively watch broadcast TV programs but also actively inquire program information and retrieve desired programs in a timely manner. The functions of a TV are now extended to general media services as well as web accesses. Most interactive TV today can provide customized services such as stock information, news, forecasting, game, etc. However, most interactions happen between the remote server and the audience, and TV only serves as a means for display and a command receiver.

Most digital TV's are equipped with a microprocessor possessing computing power of various degrees. It is becoming more feasible to design better user interface and richer functions at the client side of a TV system (set-top box or the TV itself) to facilitate better interactivity. The authors in [1] suggested that virtual characters can play the role of assistant in consumer electronics to provide operational and informational aids. In this work, we propose to design a context-aware animated

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character with emotive body expression to provide better visual effects in various scenarios of an enhanced digital TV with new interactive functions.

In order to study the effects of the proposed interface design on interactive TV, we have adopted a procedural animation system and an experimental platform for interactive TV, called Smart Interactive TV (SITV), implemented in our previous work [3,2]. On SITV, several context-aware functions based on remote TV controller and web camera have been implemented to provide convenient user experiences. However, in the previous work, only textual dialog boxes were available for delivering messages to the user. In this work, we attempt to incorporate an animated character in the user interface and define the scenarios and corresponding actions that an animated character should take to respond to a given event. In this paper, in addition to describing the system design, we also focus on the psychological experiments that we have designed to study and compare the effects of three different interfaces: regular dialog box, animated character without emotive expression, and animation character with emotive expression.

2 Related Work

Due to the development of computer technology and digital TV in recent years, there exist several application framework and solutions for digital TV or interactive TV. For example, TiVo [11] is a popular service that can provide customized TV watching experience. In our previous work on SITV [3], we have designed new instrumental services such as providing customized volume adjustment, channel recommendation functions and psychological services. We have used this system in this work to design and evaluate new interface in the emulated TV system.

For an animated agent to be believable, it is crucial for it to be able to express appropriate emotion in a given scenario. In addition to facial animation that is commonly used in character animation, body gesture is also important for emotion expression. Diederiks [7] repositioned the role of animated character in a smart environment and pointed out that nonverbal expression should be better utilized in addition to verbal expression when designing a virtual agent for user interface.

As the advances of character animation, adopting animated virtual agent as an interface for delivering messages is becoming popular. For example, the authors in [8] developed a system taking textual contents and gesture commands for a speech to generate corresponding animations and synchronized voice for a virtual weather forecast reporter. Thalmann and Kalra [5] have also designed a virtual actor for TV program. Seron [10] developed an animation engine that can generate animations of a virtual presenter delivering a speech with the voice of the author and interacting with the audience.

3 System Design and Implementation

Our system consists of two subsystems, whose results are composed through a video compositor to overlay the character animation on the TV program. The TV program runs on the SITV system [3] which emulates a live TV program broadcasting environment. This subsystem was customized based on the Window MCE edition and provided controllable content delivery for experimental uses. The character animation system was designed based on a procedural animation system implemented in Java in our previous work. This subsystem can generate character animation in real time with a given set of parameters specifying the desired animation. The two subsystems are connected through sockets for communication. We have designed a simple protocol for the SITV subsystem to send scenario description to the animation subsystem for the synchronous generation of appropriate animation.

3.1 Problem Definition for Motion Generation

We assume that our 3D virtual character moves in a 3D space that can be projected onto the TV screen. Since the dialog box and menus are displayed at different locations of the screen, in order to give the user a better sense of depth on a 2D screen, we assume that the character moves on a slanted surface such that it moves higher on the screen when it moves into the screen. In our interactive TV system, the character should be able to move appropriately and expressively according to the context of a given scenario. Therefore, we consider the problem of motion generation by taking the following factors into account: *motion*, *scenario*, and *character* as described in more details below.

Motion: An animated character is given a set of motion abilities, each of which is described with two attributes: *expressiveness* and *mobility*. First, it is important for our animated character to be able to express its emotion for a given scenario. However, if a virtual character on the screen is not large, facial expression may be difficult to tell. As pointed out by Meeren [6], body expressions have higher priorities than facial expressions when perceived by a viewer. Therefore, in this work, we use full-body gestures to express emotion when delivering a message.

Since different motions may carry different emotive meanings, we specify the range of emotion expressiveness for each motion procedure that we have designed. We adopted the basic emotion model that is commonly used in affective computing and select four common ones: *happiness*, *sadness*, *anger*, and *fear* in our implementation. Second, in order to attract the attention of the user to a message delivered by the system, the animated character in our system may move to a target location to play a selected motion. Therefore, our character needs to have mobility. For each motion defined in our system, we specify the degree of their mobility by the speed and striding ability of the given motion.

Character: In addition to motion ability, the model for each character also contains variables about its current status such as position and tiredness. The current position will be used as an input to the motion generation program to generate feasible motions moving the character to the goal. The tiredness parameter is used to adjust the strength of the emotion parameter when the motion generation problem is specified. In addition, when the accumulated tiredness reaches a threshold, the character may voluntarily decide to leave the screen to take a rest and come back later.

Scenario: In a smart interactive TV system, different interactive functions may be triggered based on different interaction scenarios and user needs. In SITV, we have implemented several instrumental and psychological services to enhance user experience. Each of these services entails a usage scenario requiring delivery of different types of messages such as warning and reminder. For example, when a user (could be a kid) sits too close to the screen, a warning message will be issued. When a user leaves the scene temporarily, a gentle reminder to suspend the TV program will be issued. We have classified the scenarios into three categories: self-initiated move by animation character (e.g. leaving the screen for a rest), SITV functions (e.g. sitting too close), and interaction initiated by the user (e.g. frequent channel switches).

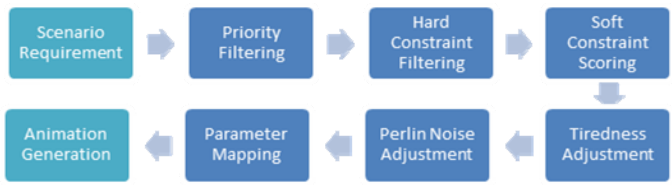

Fig. 1. Procedure for generating character animation

3.2 Generation of Character Animation

In this work, we have used the procedural animation system developed in our previous work [3] to generate character animation. The animation system takes motion descriptions from an xml file with a wide range of parameters specifying how to express different emotions with different strengths. In this system, we have implemented various motion procedures to generate common locomotion such as walking, running, and jumping. We also have implemented some customized ending motions such as waving, pushing, head shaking, pointing, listening, and boxing.

The system is able to generate expressive animation by specifying parameters at the emotion level. In our previous work [2], we proposed a hierarchical representation of motion parameters including four layers: procedure, motion, style, and emotion. Appropriate mapping between these layers through experiments has been explored. We found that the style parameters of stiff-soft, slow-fast, and expanded-extracted are more effective in expressing emotions. For example, happiness can be better expressed with softer, faster and more expanded motions; anger can be better expressed with more expanded motions; fear can be better expressed with stiffer, slower, and extracted motions. These styles can be specified with some quantitative values such that we can express the motions with finer granularity. Emotion expressiveness can also be affected by the type of motions in addition to the way it is expressed. Therefore, we have also defined the range of expressiveness of each motion for each basic emotion such as anger, fear, etc.

3.3 Animation Specification and Generation

The main procedure for generating character animation is depicted in Fig. 1. According to a given scenario, we first prioritize the tasks for the animated character and decide which action to take. The list of motions suitable for the given scenario will then be filtered according to the specified hard constraints and then scored according to the criteria of soft constraints. In order to add variations to the animation, the chosen motion with the highest score will be adjusted according to the tiredness of the character and with some random noise [9] on the parameter setting. Then the parameters specified at the emotion layer were mapped to the style layer and then to the motion and procedural layers to generate the desired animation.

(a) (b)

Fig. 2. Snapshot of SITV incorporating animated character

In the priority filtering module in Fig. 1, each motion is given a priority which is used to resolve conflicts when two requests of motions are overlapped. In the hard constraint filtering module, the available motions are filtered according to the list of hard constraints, such as required final position, desired time, and emotion, for a given scenario. We also have taken into account soft constraints, usually indicating preferences on the given scenario in the soft constraint scoring module. The tiredness adjustment module and noise adjustment module are used to add variations to a given motion to make it look more natural.

4 Experimental Designs

In order to understand how users perceive 3D intelligent characters as the interface of interactive TV, we have used the aforementioned character animation system to design two characters (normal and intelligent) in addition to the original interface based on textual dialog boxes. We will describe the three types of interfaces and our experiments on the evaluation of these user interfaces.

4.1 Description of Three User Interface Types

In the original design of SITV, dialog boxes are used to prompt messages related to the events that are happening. In this work, in addition to the dialog messages, we also have designed two types of animated character as the interface. The appearance of the two characters is the same but they differ in the emotion expressiveness of the generated motions. The three types of interfaces for comparison are as follows:

1) Interface A: dialog box with text
2) Interface B: regular animated character along with dialog box but without emotive expression (see Fig. 2a).
3) Interface C: emotive animated character, the same as Interface B, except for that it uses emotive expression (see Fig. 2b).

We have designed two experiments to study the effect of the three user interfaces on various interactive TV scenarios.

4.2 Experiment 1: Preliminary Comparative Study of User Interface

The objective of this experiment is to understand the impression of the subjects on these interfaces from an observer's point of view. We prepare nine videos for three scenarios and three interfaces in advance and show the videos to 30 subjects who were asked to provide their feedbacks by filling a survey at the end. The three scenarios that have been used in the experiment include login, getting too close, and temporarily leave and return. We have adopted the within-subjects design for the experiment. The independent variables are the three user interfaces and the three scenarios. The only dependent variable is the scores (-100 to 100) filled in by the users.

Table 1. The mean scores on five aspects for 3 (interfaces: A, B, and C)×3(scenarios) conditions in Experiment 1

	Login			Getting Too Close			Leave/ Return		
	A	B	C	A	B	C	A	B	C
Amusement	16.43	30.07	39.23	16.10	31.37	52.33	22.20	24.67	41.70
Novelty	14.37	41.77	44.40	25.13	40.10	50.30	27.00	35.40	45.67
Fondness	32.33	14.77	22.60	53.47	- 9.90	30.07	47.60	- 9.30	17.43
Understandability	56.50	41.33	36.87	64.67	47.67	58.33	60.77	40.27	53.93
Willingness to use	36.03	22.03	21.77	53.30	-19.20	27.00	47.77	-10.23	12.03

We asked the subjects questions about the following five aspects of the system: *amusement*, *novelty*, *fondness*, *understandability*, and *willingness to use*. The mean scores on these five aspects for three interfaces in each scenario are listed in Table 1. Two-way ANOVA on each of the five aspects separately shows that the main effects of interfaces are all significant ($F(2,58)$=12.64, 22.10, 17.97, 7.05, 18.75, respectively, $p<.05$). Post hoc comparisons with Tukey test show that the user interface with emotive animated character (Interface C) is significantly better than the interface with dialog box (Interface A) in amusement and novelty. However, Interface A is significantly better than Interface C in the aspects of fondness, understandability, and willingness to use. The interface with regular animated character (Interface B) has the worst overall performance. In other words, although the interface with animated character is more interesting to see, it is also less understandable compared to the dialog box interface.

4.3 Experiment 2: User Experience Assessment

With the result of the first experiment, we would like to further understand how the users assess the interfaces when they are placed in the real scene and operate the interactive TV with these interfaces. We have installed the SITV system in a living lab as shown in Fig. 3 for our second experiment. The experiments were conducted in two days separated by one week for ten subjects. In the first day, each subject was asked to operate the three interfaces in sequence and then choose any interface to watch the TV for the next 30 minutes. In the second day, the order was reversed, free watching and then exercising the three interfaces in sequence. At the end of each day, the subjects were asked to fill in a survey form and receive an interview.

Fig. 3. Living lab with the SITV system for the second experiment

Table 2. The mean scores on eight questions for the 3 (interfaces: A, B, and C)×2(day) conditions in Experiment 2

	Day 1			Day 2		
	A	B	C	A	B	C
Amusement	52.00	60.90	55.30	38.70	48.10	57.60
Novelty	48.80	61.80	57.60	43.30	48.80	52.40
Fondness	41.90	42.70	37.50	46.10	24.20	51.70
Understandability	22.30	48.70	42.80	58.40	62.90	67.10
Willingness to use	38.70	44.90	40.10	41.20	27.60	50.50
User friendliness	47.60	60.20	61.30	54.10	45.30	57.00
Good design	47.00	50.60	45.50	42.40	39.90	49.70
Desire to have	46.70	49.40	43.10	38.50	18.40	45.10

The experiment uses the within-subjects design by having the three interfaces and experimental days as the independent variables. The dependent variables are the scores (-100 ~ 100) that the users enter for the survey questions and the times for different types of interfaces. We asked the subjects to score the interfaces according to eight questions including the five in the previous experiment. The mean scores on eight questions for the three interfaces in Day 1 and Day 2 are listed in Table 2. The experimental data reveal that in Day 1, the most differences among the three interfaces are on amusement, and novelty, and understandability. The dialog box interface (Interface A) has the lowest scores in these questions. But the simple effects of ANOVA show that the effects of interfaces in Day 1 are all insignificant except for understandability ($F(2,18)=5.52$, $p<.05$). Tukey test indicates that Interface B is significantly more understandable than Interface A. Interface C is also higher than Interface A on understandability, but only marginally significant. In Day 2, we found that the differences on novelty and understandability have decreased. Simple effects of interfaces in Day 2 are significant on amusement, fondness, and desire to have ($F(2,18)=6.96$, 4.37, 4.22, respectively, $p<.05$). Tukey test indicates that Interface C is significantly superior to Interface A on amusement. Interface C is also significantly superior to Interface B on amusement and desire to have. By comparing the data in the two days, we found that the scores for Interface B have dropped significantly and becomes the worst one. In other words, once the user become familiar with the interface containing an animated character, the expressiveness of the character becomes more important. Improper or dull character behaviors will make the interface worse than a pure text-based interface after the freshness disappears.

5 Conclusions

In this work, we have used the SITV platform as a basis to develop new interactive TV functions and a new user interface with animated character. We believe that this study is the first work on realizing an emotive animated character based on the scenarios of using an interactive TV. We have defined the problem of how to generate expressive character animation for a set of given scenarios on interactive TV. The expressive animation with emotion is generated in real time by taking advantage of our previous work on procedural animation for emotive motions. A planner is used to search for the most appropriate motions in terms of mobility and expressiveness from a library of animation procedures. In order to assess the new user interface with animated character, we have designed two experiments to compare the new interface with the base-line dialog box interface. We have found that although the interface with animated character can attract the attention of the user and enhance interactivity, the text-based interface is still the easiest to understand. We also have found that when the freshness of the new interface decays after some time of use, it is crucial for an animated character to have expressive motions.

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References

1. Diederiks, E.M.A.: Buddies in a Box - Animated Characters in Consumer Electronics. In: Proc. of the 8th Intl. Conf. on Intelligent User Interfaces, pp. 34–38 (2003)
2. Lin, Y.-H., Liu, C.-Y., Lee, H.-W., Huang, S.-L., Li, T.-Y.: Verification of Expressiveness of Procedural Parameters for Generating Emotional Motions. In: Proc. of the Eight Intl. Conf. on Intelligent Virtual Agents (2008)

3. Liu, P.-Y., Hsu, S.-W., Li, T.-Y., Lee, H.-W., Huang, S.L.: An Experimental Platform for Smart Interactive TV in Digital Home. In: Proc. of 2007 Symp. on Digital Life and Internet Technologies, Tainan (2007)
4. Ludwig, B., Mandl, S., Mammen, S.V.: What's on tonight - User-centered and Situation-aware Proposals for TV Programs. In: Proc. of International Conference on Intelligent User Interfaces, p. 258–260 (2006)
5. Magnenat-Thalmann, N., Kalra, P.: The Simulation of a Virtual TV Presenter. In: Proc. of Pacific Graphics 1995. World Scientific, Singapore (1995)
6. Meeren, H.K.M., van Heijnsbergen, C.C.R.J., de Gelder, B.: Rapid Perceptual Integration of Facial Expression and Emotional Body Language. Proc. of the National Academy of Sciences (2005)
7. Nijholt, A.: Where computers disappear, virtual humans appear. In: Proc. of Computers and Graphics (2004)
8. Noma, T., Zhao, L., Badler, N.I.: Design of a Virtual Human Presenter. IEEE Computer Graphics and Applications 20(4), 79–85 (2000)
9. Perlin, K., Neyret, F.: Flow Noise. SIGGRAPH Technical Sketches and App. (2001)
10. Seron, F., Baldassarri, S., Cerezo, E.: Maxineppt: using 3D virtual characters for natural interaction. In: Proc. of the 2nd Intl. Workshop on Ubiquitous Computing & Ambient Intelligence (2006)
11. TiVo, `http://www.tgc-taiwan.com.tw/`

A Novel Approach of Learning English with Robot for Elementary School Students

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Abstract. Early school years are an important period to lay out the foundation for learning a second language. In addition to mastering basic language skills, keeping the learning process fun; promoting a life-long learning habit must be emphasized. This study explored the integration of books, computers and robots to create a novel English learning environment. Books are the most popular and familiar learning media. However if we can design a special mechanism linking books with digital learning material and robots, students will be able to obtain supplementary learning content. This mechanism includes meaningful action performed by the robot to enhance learning outcome. A new learning system has been designed and developed. The learning system was tested while data collected from field observation and interviews were analyzed. The results suggest that this system was fertilized students' learning experience and enhance students' concentration, learning interest and motivation.

Keywords: Book, Digital learning material, Robot, Learning English.

1 Introduction

Crystal [1] mentioned that about a quarter of the world's population is already fluent or competent in English. Being able to communicate in English will be helpful in adapting oneself to the international society. Many non-English-speaking countries regarded English as an important foreign language and are committed to improving students' fluency in English [2].

Developmental social psychology [3] suggested that human development consists of eight stages, with each stage corresponding developmental outcomes and strengths. Erikson suggested that failure in one stage will cumulate and hinder the development of the stage that follows. Positive experiences in achieving the stage outcome serves as a foundation for later development, whereas negative experiences resulted from encountering challenges in a particular stage will undermine subsequent development. It is important to motivate young students to learn English while keeping the learning process joyful and enjoyable to gain positive language learning experiences.

We considered integrating books, computers and robots to create an English learning environment. While many emerging technologies have been applied to support English learning, Bannert et al. [4] suggested that the combination use of traditional books and technology-enhanced learning outperformed the mere use of

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e-learning materials. Books are the most popular learning medium thus integrating digital learning materials and robot into conventional usage of books not only reduces the distraction resulted from context switching in the book, but also enriches the representation of plain text with multimedia and motions. For example, Neri et al. [5] suggested that applying computer technology to provide students with correct pronunciation of vocabulary benefits students learning a foreign language. In addition, the robot provides a more concrete way of explaining abstract concepts hence fostering deeper understanding in learning [6]. To be able to take full advantage of different learning resources, a well-designed integration of books, digital learning materials, and robot is needed.

This study aimed to explore the integration of books, computers, and the robots from three perspectives: (1) instructional design, the way to design and develop an integrated approach to effective English learning; (2) system evaluation, if this integrated system can be useful in motivating student to learn English language; and (3) usability, how much students favour this system in terms of their acceptance and willingness to use this system in the future. We first address the notion of system design and the explanation of learning-support functions, followed by the methodology, results and findings. We then discussed some relevant issues in this study and provide suggestions for future research.

2 The Design of the Learning System

Nowadays people learn from reading books and turn to computers or other resources for additional information when encountering difficulties. This conventional way of learning has two potential problems. First, learning a foreign language solely from books has limitations as mentioned earlier. Print text does not provide multimodal information such as audio or video to learners nor can it interact with the learner to provide feedback which is important for learning a foreign language. Second, learning with books and the computer as two separate resources is less efficient and one can easily get distracted when switching back and forth between two different contexts. For example, when one encounters some difficult words in reading, he or she would go online to look up the words in an online dictionary. When looking up the words online, the student may turn to the news or emails in addition to learning new words. Switching learning contexts as such could potentially distract the learner from what he or she was learning, and defeat the learning process.

Second, the computer-assisted learning systems lack enough interactivity that motivates students to actively participate in the learning activities.

Third, as Liu [7] noticed, learners often have insufficient practice in spoken English after class, which results in the situation were students are not confident in speaking in English. Part of the reason is that students are not motivated to use English language after class. A computer-assisted learning system, thus, should be able to engage students in practicing their oral English in the real context simulated by the computer system.

Considering all of the above issues, a game-based learning environment can be the best option in building a learning system to motivate students to actively participate in learning activities [8] and to enhance their engagement in learning [9]. We used both verbal and pictorial representations in the learning material to benefit students' understanding [10]. The robot, Bioloid, was employed in the present study because of its low cost and high versatility [11]. We used this system to create a context in which the learner is allowed to interact with the system and receive feedback from the system. This two-way interaction is made possible in the proposed learning-support system.

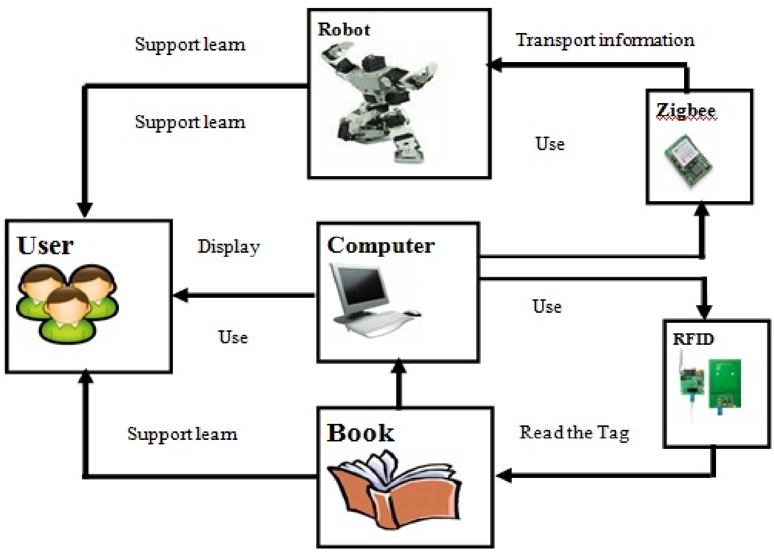

Fig. 1. The architecture of the learning system

We used radio frequency identification (RFID) system to connect the book and computer, and Zigbee technology to connect wirelessly the computer and robot. Among recent development of wireless communication technologyies, RFID features low cost, intuitive operation, and contextual adaptability which attracts much attention. It has been widely used in our daily life, as well as educational settings [12]. Similarly, the Zigbee technology, which has been adopted as one of the communication standards, features low power consumption, low cost, high reliability, and multi-node support, and was used in this system to provide stable wireless signal transmission between the computer and robot. The Zigbee technology frees the robot from the cable connection that could constrain the robot's movements and motions.

In the learning practice, as shown in Figure 1, one can learn English with the orchestration of the book, computer, and robot. When a learner has difficulties in understanding certain vocabulary (or sentence), he or she uses the RFID reader to point to the word (or sentence). The RFID reader detects RFID tags embedded in the book and transmits the object information to the computer. The computer then fetches the stored multimedia object associated with the RFID tag and displays the lexical information on the screen together with the audio and/or video output. Meanwhile, the robot receives the request sent out by the computer via the Zigbee signal and performs the corresponding motion(s) to help the learner better understand the meaning of the word (or sentence). All these processes are initiated by the learner during the learning activity.

3 System Implementation

The learning-support system consists of six types of learning activities, including vocabulary, single sentence read-along, full article read-along, conversation, singing and dancing, and cloze test. The features of each learning activity are described below.

3.1 Vocabulary Learning

In this system, students used an RFID reader to point to pictorial icons in the textbook. RFID tags were embedded in the pictures. When the RFID reader detects the touch action of the icon, and it sends the identity of that learning object to the computer. The computer fetches the corresponding multimedia information from the database and presents it to the learner. For instance, if the RFID reader approaches to the specific icon, a video clip will be displayed on the computer. The computer will utter the word. In this way, learning vocabulary does not require learners to use the keyboard, hence no keyboarding is necessary.

3.2 Single Sentence Read-Along

When a learner does not understand a particular sentence, he or she can select a single sentence to read along as many times as he or she needed. The computer will play the sentence and the robot will perform the corresponding motion. This makes learning reading sentences more enjoyable and enriches learner's learning experience.

3.3 Full Article Read-Along

Being familiar with each single sentence, the learner can proceed to read the whole article along with the computer. The icon  shown in Figure 2 indicates the function of reading the whole article with the computer.

3.4 Conversation

To help learners obtain a more realistic experience in spoken English, this part of the learning activity provides the learner with an interactive way of practicing conversation. In a fabricated context, the learner is allowed to play one role in the conversation, whereas the robot plays the other. Through the microphone, the learner can "really" talk to the robot, and the robot will act and move according to the content of the conversation. This feature makes the conversation as realistic as it happens in daily life. The example shown in Figure 2 illustrates how the conversation activity can take place. First, the learner chooses a role for the robot. In this case, the learner wants the robot to play Sam, he or she uses the RFID reader to sense the icon 

to be Sam. Likewise, if the learner wants the robot to play the role of Peter, he or she can use the RFID reader to sense 

. After choosing the role, the conversation begins.

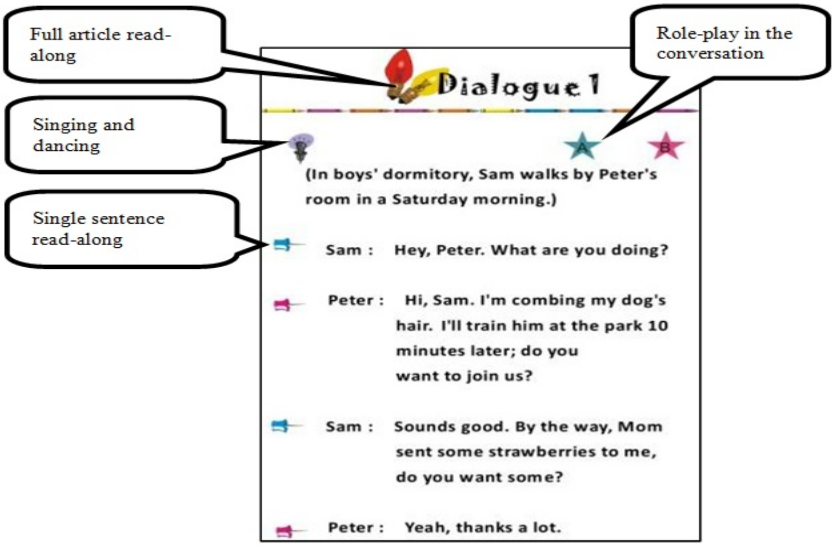

Fig. 2. An example page of the conversation activity

3.5 Singing and Dancing

To learning vocabulary, sentence, and the conversation, the proposed system also provides the function of singing and dancing performed by the robot. The system will play the song once. As the computer is playing the song, the robot will dance along the song, and asks the learner to sing (or dance) along with the robot.

3.6 Cloze Test

We provided learners an alternative to learn English by filling in blanks. We selected a bunch of verbs and attached RFID tags to them. In a story, where the verbs are missing, the learner is allowed to fill in the blanks with proper verbs by sensing the RFID reader to them. There is no correct answer for the story, so the learners can make their own story by varying verbs in the sentences. The robot will perform the motion corresponding to the selected verb. After completing the whole story, the robot can perform a series of motions according to the story.

4 System Evaluation

We applied qualitative research methods with five fifth-graders (three boys and two girls) participated in this study. These students were using a textbook (with RFID tags embedded in it), a laptop along with an RFID reader, and the robot. The procedure of the experiment is described in Table 1.

Table 1. Procedures of the experimental English course

Steps		Purpose and observation
1	1.1.	Introduce students to the system and its features
	1.2.	Observe how the student reacts to the system (the robot).
2	2.1.	Instruct students on how to use the system to learn English
	2.2.	Observe how the student learns English in terms of the joyfulness, & active participation.
3	3.1.	Interview with students about their learning experience & obtain feedback
4	4.1.	Interview with the teacher and consult him/her on how to help students learn better with the system, and the comparison of the system with others similar systems, and possible improvement of the ystem

5 Results and Discussion

5.1 Video Recordings

The proposed system is easy to use and motivates student to English learning. At the beginning of the experimental course, all five students were able to operate this system shortly after the researcher's demonstration and proceeded to the learning activities, given that they did not have prior experience of using the system. During the whole learning process, all five students concentrated on the learning materials shown in the screen and the robot. They took turns to use the system, and were fully engaged, actively participated in the learning activity. It is evident that students were highly motivated and having fun while learning in the process.

5.2 Interviews

Students preferred learning in an interactive environment. Four out of the five students enjoyed the activities of conversation, singing and dancing (dancing with the robot). It is apparent that students preferred learning English in a more interactive fashion.

Students preferred learning vocabularies with pictorial representations. Three out of five students expressed that "the new way of memorizing vocabularies is better than the traditional learning system because the new system provides a corresponding picture and word along with the animation, which brings forth a deeper understanding."

Interacting with the robot is fun. Four of the five students mentioned that they "enjoyed having conversation with the robot because the robot performed the motions." Interacting with the robot helps students obtain the first-person experience in conversation, which enriches the interactions between the learner and computer.

Practicing conversation with the robot helps students become more confident in speaking English. Three students expressed that "a long-term practice of conversation with the robot will help me feel more confident in speaking English." Therefore, we believed that the use of robot encourages students who are reluctant to speak English to have conversation with the robot, and through this process students build up confidents in their spoken English and willing to communicate in English.

Students have a positive toward using the system to learn English. Students gave positive feedback to the system. Four students mentioned that "this system facilitates the practice of vocabulary, pronunciation, and conversation after class because we can learn the word and its pronunciation without typing the word into the computer or looking it up in the dictionary."

Multimedia effects could be attractive but may not last long. The teacher mentioned that "learning with multimedia could be fascinating to a large number of students at the beginning, but the learning effect will fade away if there are no continuous updates to the material."

The cost could be an issue. The principal mentioned that "the cost of the learning system will influence parents' decision to adopt the system in learning English." Considering the cost, therefore, the scalability and compatibility of the learning system needs to be taken into account in designing and developing the system. In our case, the content materials should be updatable, changeable, and replaceable, such that the computer, robot, and RFID facilities can be re-applied to other disciplines to keep the learning cost reasonable.

6 Conclusions, Suggestions, and Future Study

This study attempted to integrate the books, computer and robot to develop an English learning system, and to understand if the system is useful in motivating students to learn English in terms of the engagement, joyfulness, and activeness. We designed six types of learning activities in the system. In each learning activity, the computer provides pictorial representations and animations along with audio effects to students. Students interacted with the computer by an RFID reader to read the function icons or word cards (embedded with RFID tags) which lowers the overhead in the interaction with the computer system. The use of robot benefits students in obtaining a first-person learning experience in conversation, singing and dancing with the robot. Students felt comfortable in practicing oral conversation with the robot.

The field observation and interviews suggested that this system can indeed motivate elementary school students to learn English and engage them in learning activities. The students were all positive towards the system and enjoyed learning with the system. The design of the system provides students a context that is highly interactive which surpasses that of conventional computer-assisted learning systems.

Future research of this system can be focused on several aspects. First, we will develop an authoring tool which allows learners to design or compose the animation and robot's motions to help deepen learners' understanding of the learning content. Second, we will develop a composing tool which allows students to upload their favourite English songs and to have the robot dance along with the new song. We expected that the speed of narration can be adjusted according to the user's needs. Third, the current system was developed on platform of a laptop computer. In the future, the system should be scalable and transplantable to mobile devices such as PDA or smart phone to make it portable and movable. Also, digital learning materials should be unloadable to the Internet (e.g., the cloud servers), so that the learners can access those materials anytime, anywhere.

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References

1. Crystal, D.: English as a global language, 2nd edn. Cambridge University Press, Cambridge (2003)
2. Liu, T.Y.: A context-aware ubiquitous learning environment for language listening and speaking. Journal of Computer Assisted Learning 25, 515–527 (2009)
3. Erikson, E.H.: Childhood and Society, 2nd edn. Norton, New York (1963)
4. Bannert, M., Hildebrand, M., Mengelkamp, C.: Effects of a metacognitive support device in learning environments. Computers in Human Behavior 25, 829–835 (2009)
5. Neri, A., Mich, O., Gerosa, M., Giuliani, D.: The effectiveness of computer assisted pronunciation training for foreign language learning by children. Computer Assisted Language Learning 21, 393–408 (2008)
6. Zhang, Y., Kinshuk, Jormannainen, I., Sutinen, E.: An implementation of the agency architecture in educational robotics. In: 8th IEEE International Conference on Advanced Learning Technologies, pp. 194–198. IEEE Press, Spain (2008)
7. Liu, H.-C.: Assessing learner strategies using computers: New insights and limitations. Computer Assisted Language Learning 13, 65–78 (2000)
8. Coller, B.D., Shernoff, D.J.: Video game-based education in mechanical engineering: A look at student engagement. International Journal of Engineering Education 25, 308–317 (2009)
9. Kebritchi, M., Hirumi, A.: Examining the pedagogical foundations of modern educational computer games. Computers & Education 51, 1729–1743 (2008)
10. Chen, C.M., Chung, C.J.: Personalized mobile English vocabulary learning system based on item response theory and learning memory cycle. Computers & Education 51, 624–645 (2008)
11. Birk, A., Poppinga, J., Pfingsthorn, M.: Using Different Humanoid Robots for Science Edutainment of Secondary School Pupils. In: Iocchi, L., Matsubara, H., Weitzenfeld, A., Zhou, C. (eds.) RoboCup 2008. LNCS, vol. 5399, pp. 451–462. Springer, Heidelberg (2009)
12. Harumi, K., Yan, X., Yi, S., Min, K., Kazuhiro, O.: A language learning system utilizing RFID technology for total physical response activities. In: 13th International Conference on Human-Computer Interaction, pp. 119–128. Springer, San Diego (2009)

Framework for Educational Robotics: A Multiphase Approach to Enhance User Learning in a Competitive Arena

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Abstract. Educational robotics involve using robots as an educational tool to provide a long term, and progressive learning activity, to cater to different age group. The current concern is that, using robots in education should not be an instance of a one-off project for the sole purpose of participating in competitive event. Instead it should be a sustainable long term progression spanning the primary school to pre-university level. This paper presents a framework for robotics using a multiphase approach to enhance user learning in a competitive arena.

Keywords: Education, robotics, framework, competition, arena.

1 Introduction

Current advancement in educational technologies has opened up a diverse range of opportunities in enhancing teaching and learning. Having the availability of these technologies, it is vital to integrate and construct teaching and learning environments to maximise the potential of such technology to enhance the delivery of subject material. This study investigates such a potential using educational robotics. As the technology progresses, it has allowed robots to leave laboratories and manufacturing factories and make it out into schools and homes. Since Papert [18][20] and Mikhak et al [15] started using robots in children education, it has gained much attention and success [6][7]. Robot-human interaction (RHI) is widely used to support teaching and learning science, technology, engineering and mathematics (STEM). STEM includes learners from primary to secondary level students; and undergraduate to graduate research [5][8][13][14]. However, the increasingly popular use of robotics in education lacks the accessibility for the non-expert users, particularly for junior to lower-secondary level students [5][11]. There is a need for a structured framework that provides support in teaching and learning of technical based subject areas using robotics. This paper aims to investigate the educational use of robotics and its related issues by constructing a theoretical framework to assist teaching and learning. An intelligible *robotic development environment* (RDE) in robot development suitable for non-expert

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users will be designed and built to support this study. In this paper, the framework is demonstrated on a multiphase *search and rescue* (SAR) competitive arena.

2 Educational Robotics

Using robots as an educational tool to teach children began in the early 1980s when Papert (1980, 1986) proposed the constructionism approach, where learning is achieved most effectively by participation in the construction of robotic artefacts. Children can learn through the process of designing, building and programming their own robots. Educational robotics is also based on the learning principles derived by Papert, which he later introduced as constructionist learning methodology. Resnick and Ocko (1991) at MIT media lab based their research on Papert's philosophy and started the development of LEGO/Logo. They combined LEGO Technic products with the Logo programming language that allowed children to build and program robots. This learning-by-doing method has received much attention in recent years.

Current research trend involves using robots as an educational tool to provide a long term, continuous fashion, to cater for different age group. They are concerned that using robotic in education should not be an instance of a one-off project for the sole purpose of participating in competitive event. Instead it should be a sustainable long term progression spanning the primary school to pre-university level [5][6]. Chiou demonstrated a work-in-progress framework for *multi format robot search and rescue (SAR),* where it provides accessibility to all participants ranging from young age children to postgraduate researchers. He suggests that young age children may participate in the challenge using robot construction kits such as Lego NXT and Fischertechnik. Once the early phases have been achieved, student will then be more prepared to attempt the next level of SAR competition and thus "allow participants to progress from one phase to the next as their technical knowledge and skill improves". Currently there exist few standardised framework that support these learning activities in a holistic approach [16][24].

3 Objectives

The significant of this research has manifolds – the proposed framework provides a model for teachers and researches to teach STEM using robotics and with the identification of each construct and their relationships to the framework. This helps in understanding the overview of how robotic being the embodiment of these constructs. This study also support and demonstrates the theory of PBL and constructionism which are beneficial in *computer aided learning and training* (CALT). In utilising the concepts inherent in the study of robotics, it provides an alternative approach to novice users from various disciplines and background to gain access and in learning abstract concept of computing and programming. Edutainment robotics has been a dynamic research area in recent years [1][2][14]. Hence the result of this study will contribute to this innovative form of teaching and learning. It is also the intention of this endeavour to create awareness of the potential of robotics to a wider audience.

4 Theoretical Background

The framework proposed in this project is supported by the Norman's (1986) theory of action and its *gulf of execution* and *gulf of evaluation*. Further extension of this theory is proposed to complement and support the framework of this project, with the addition of a *development environment*, *physical system (autonomous robot)* and *operational environment.* Finally the proposed framework for this research is presented which built upon the foundations introduced by Carroll (2002).

4.1 Norman's Theory of Action

Norman's (1986) foundational theory of action states the seven stages of activity that are to take place from when an idea is conceived to the actual stage the idea actually takes place. The seven stages are: *establish a goal, form an intention, specify an action sequence, execute an action, perceive the system sate, interpret the state and evaluate the system state with respect to the goals and intentions.* Ideally, Norman's theory of action is to take place sequentially. However, it is now well understood that human users do not operate in this way in reality. For example, a user may begin by several approximations of their intended ideas as in contrast to one (i.e. 'establish *a* goal'). Nonetheless, the sequence of action can be iterated to arrive at a satisfactorily conclusion of the conceived idea. This is perhaps the foundation to many software engineering development frameworks. In this regard, the application (e.g. graphical user interface, software development environment, etc) determines what and how subsequent actions are to be undertaken. In this way, the stages above do not indicate equal weighting. In spite of its shortcomings, Norman's action stages do prescribed and have identified that providing feedback is an important phase of any action. Complementing this theory is the gulf of execution and gulf of evaluation.

4.2 Gulf of Execution and Gulf of Evaluation

The 'gulfs' in this theory attempts to explain the gaps between the user and the interface, and in the context of this project, the gulfs that separate the user's perceived goals and the deployed robot in the physical challenges. Here, they [9][17] provide the guidelines on how to design these interfaces to narrow the gaps between the user and the interface, hence providing optimal accessibility to the user. In Figure 1 (unshaded zone), the gulf of execution depicts the distance from the user to the physical system while the gulf of evaluation is the distance from the physical system to the user. Based on the summation of the distance of these gulfs, Norman suggests that the responsibility of the developer is to ensure that they concern themselves with how to bridge these gulfs.

In the last two to three decades, these gulfs have had impacted on how researchers approach designs of interfaces and development tools. Quintana et al (2000) have approach their learner-centred design (LCD) based on the theory of gulfs. This is evident in their endeavour to emphasise the need to bridge the 'gulf of expertise' between a learner and the domain they are learning about. Also along these lines, Bellotti et al (2002) have used the theory of gulfs as the basis of their 'making sense' framework that attempts to address the challenge of developing ubiquitous computing systems.

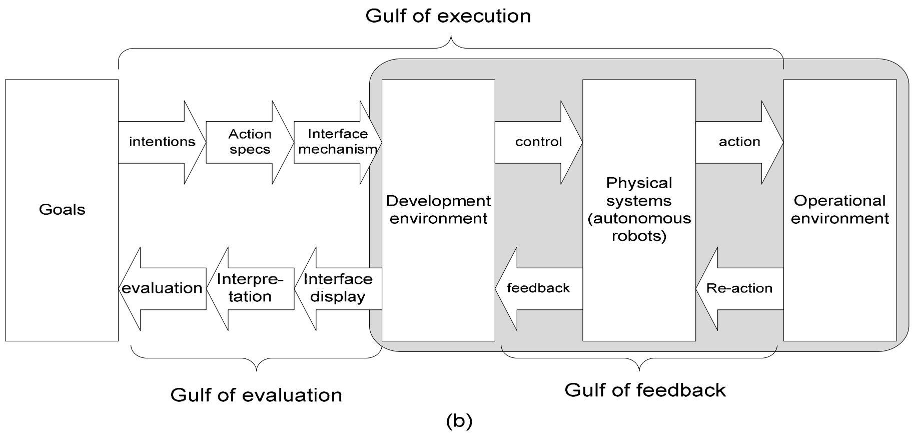


Fig. 1. Proposed extensions to the gulf of execution and evaluation

4.3 Extensions to the Theory of Action

When Norman's theory of action was conceived, it included primary constructs consisting of widely available development and equipment at the time. The trend then, was simply the interaction between the intended users and the functionality of computers through a surrogate user interface. However, this did not take into account contemporary equipment and software that has now extended the gulf even further (e.g. control systems, embedded equipment, tele- and internet-operated equipment). In order to present a more meaningful theory of action to support the proposed framework to be presented in this paper, a revision is introduced in this research to include more sophisticated degrees of separation. In Figure 1 (shaded zone), the extension now comprises of two additional *islands* (i.e. *development environment* and *physical systems*). In this extension, the theory of action is now taken into account the provision for the design, development and planning of equipments.

5 EARLY Framework

In order to demonstrate the viability of this extension, EARLY (Education Technology Advancement of Robotics Learning for Youths) framework is proposed to provide a sustainable model for autonomous robotics educational environment for teaching and learning. This proposed framework is built upon the foundations introduced by Carroll (2002). Carroll takes into account the four critical constructs that are human-centred to include *people, activities, contexts and technologies* (PACT). The PACT framework has been described in detail by Benyon (2010). These four components are essential in human-computer interaction in order to achieve perceived goals.

The EARLY framework proposed in this paper details the operational environment for a robot-human-interaction utilising blended approach to support teaching and learning. Based on the PACT framework, the primary constructs for the proposed framework are participants (P), environment (E) and arena (A) as shown in Figure 2. The following section details the sub-constructs in the EARLY framework:

Participants (P). Participants used in this framework can be of any type of users, who may be playing a role as a teacher in the class, teaching and demonstrating to students how to design and program a robot. Students, as learners, will have hands-on experience in constructing and completing the required project. Both teachers and students can be experimenters and/or builders, interacting with one another and exchanging ideas.

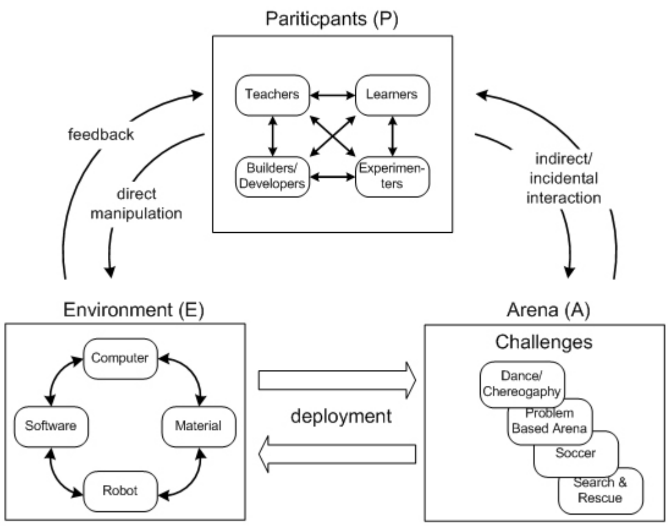


Fig. 2. EARLY Framework

Environment (E). The environment construct is made up of four sub-constructs – the computer, material, robot and software. The computer, which is an embedded control system, is used to control and manipulate different functions of the robot material. Material here may includes the exo- or endo-skeleton or shell of a robot, motors, chassis, sensors, wheels, tracks and other parts that supports the development of a physical autonomous robot with embedded microcontroller. Subsequently the robot would be controlled by software. The software is normally developed using appropriate software tool.

Arena (A). The arena is a platform for different kind of challenges for the robots. The arena is not constrained to a physical boundary, but also rules and definition of the operational area. These challenges could be a dancing robot, robot that play soccer or robot which does search and rescue. These challenges have been created in competitions such as the popular RoboCupJunior [23]. The arena could also be any problem based learning situation for the participants to design and program their robots to achieve their goals.

6 Implementation - Multi Format Robot Search and Rescue (SAR) Arena

In Figure 3, it shows that the participant has two approaches to this system – through the simulated environment and/or through the physical development environment with physical robots. While the simulated environment utilizing mainly software to re-create and manipulate robot challenges on a screen-based arena, physical development environment will actually have a hands-on construction of a robot which can be further deployed into a physical arena. This physical arena in the real world situation would be more realistic and present more challenge. Based on the EARLY framework, the development of the multi format robot competition adopts SAR arena as it provides the best platform and potential for extension [10]. The purpose of a multi format SAR arena is to provide accessibility to all participants ranging from young age children to postgraduate researchers. Each category provides continuity from one phase to the next, in turn providing increasingly more challenging problems for the participants to overcome. In this way, participants are not required to have comprehensive prerequisites to participate in a robot competition. For the purpose of the multi format robot SAR arena competition, only intelligent autonomous robots are considered. The format begins as a 2-dimensional flat arena, subsequently upgrading to a 3-dimensional arena and then finally to a problem-based arena.

6.1 2-Dimensional Arena

The 2-dimensional arena is based on the RCJ rescue robot format. Participants are to design, build and program an intelligent autonomous robot that could navigate across an arena following a pre-defined marked path to arrive at a pre-destined ‘disaster’ area to ‘rescue’ a victim. The arena is composed of 50x50cm flat surface platform tiles arranged edge-to-edge in a continuous path. The complexity depends on the age group of the participants.

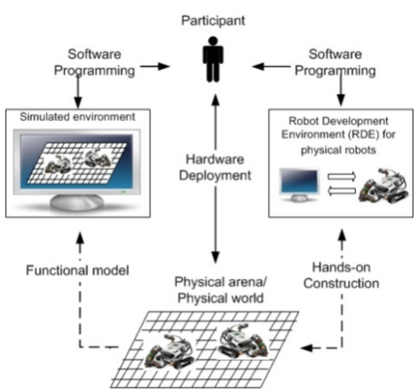
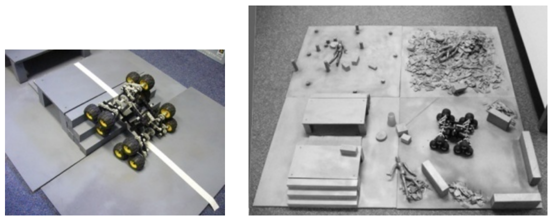


Fig. 3. Overview of physical and simulated modes

6.2 3-Dimensional Arena: Entry Level

The 3-dimensional arena is based on the 2-dimension version with added complexity. Obstacles in a variety of material are added to provide the scaled-down version of possible real-life scenarios. Understandably, the 3-dimensional arena is a huge leap from the 2-dimensional version. Hence, in order to provide continuity in terms of gradual difficulties of the challenge, two version of the arena is employed. The first has a marked path (Figure 4(a)). The autonomous robot is only required to overcome the physical obstacles minimising the need to intelligently traverse in the arena.



(a) (b)

Fig. 4. (a) 3-dimensional search and rescue robot arena.; (b) 3-dimensional search and rescue robot arena. Four platform tiles arranged in a geomorphic configuration.

6.3 3-Dimensional Arena: Advanced Level

The advance version of the 3-dimensional arena is similar to the entry-level arena without the marked path (Figure 4(b)). Also, based on the possible geomorphic arrangement, the test arenas can be arranged in any configuration depending on the requirements of the competition. It is expected that programming skills would require a high level of proficiency in intelligent computational methods [12]. The arena will be populated with effigies depicting victims in real life scenarios. The goal of each SAR robots in the test arena is to locate, and if possible, retrieve the victims. Secondary goals for the robots are to map the area and provide environmental data to the human operators.

6.4 Problem Based Arena (PBA) – Case Study

The PBA in robot competition is the outcome resulting from cumulative concepts inherited from the 2- and 3-dimensional arenas. The goal of the problem based arena is to progress into real life case studies modeled on its predecessors. Even though this may move away from the *search and rescue* principle inherent in such competitive robots, the technology and skills required remains unchanged. The purpose of this arena is to allow the participants to apply their expertise in a known problem area. By deploying this as a competition, it inevitably support a solution based approach expeditiously. In the following experimental arena, an example is presented to show how the SAR multi format is applied to one of the many problems based arena representing real-life challenges.

7 Summary

This paper has discussed the issue of educational robotics and its benefits in teaching and learning and presented a proposed framework, EARLY (Education Technology Advancement of Robotics Learning for Youths), to help in long term and progressive learning activity. This paper has also detailed the operational environment for a robot-human-interaction utilising blended approach to support teaching and learning. A multiphase *search and rescue* (SAR) with 2-dimentional and 3-dimentional competitive arena, and in additional with a problem –based arena (PBA) case study have been presented to demonstrate the viability of the EARLY framework.

References

1. Asada, M., D'Andrea, R., Birk, A., Kitano, H., Veloso, M.: Robotics in Edutainment. In: Proceeding of International Conference of Robotics & Automation (ICRA 2000), vol. 1, pp. 795–800 (2000)
2. Bellotti, V., Back, M.J., Edwards, W.K., Grinter, R.E., Lopes, C.V., Henderson, A.: Making Sense of Sensing Systems: Five Questions for Designers and Researchers. In: Proceedings of CHI 2002, pp. 415–422. ACM Press, New York (2002)
3. Benyon, D.: Designing Interactive Systems. In: A Comprehensive Guide to HCI and Interaction Design, pp. 26–45. Addison Wesley, Reading (2010)
4. Carroll, J.M.: HCI in the New Millennium. Addison Wesley, Harlow (2002)
5. Chiou, A.: Multiple Format Search and Rescue Robot as a Competitive Arena. In: Proceeding of World Congress Computing (2010)
6. Demo, G.B., Siego, S., De Michele, M.S.: University and Primary Schools Cooperation for Small Robots Programming. In: Lytras, M.D., Damiani, E., Carroll, J.M., Tennyson, R.D., Avison, D., Naeve, A., Dale, A., Lefrere, P., Tan, F., Sipior, J., Vossen, G. (eds.) WSKS 2009. LNCS, vol. 5736, pp. 238–247. Springer, Heidelberg (2009)
7. Druin, A., Jendler, A. (eds.): Robots for Kids – Exploring New Technologies for Learning. Morgan Kaufmann, San Francisco (2000)
8. Han, J., Kim, D.: r-Learning Services for Elementary School Students with a Teaching Assistant Robot. In: Proceeding of Human Robot Interaction HRI 2009, La Jolla, Calirformia, USA, March 11-13 (2009)
9. Hutchins, E., Holan, J.D., Norman, D.: Direct Manipulation Interfaces. In: Norman, D., Draper, S.W. (eds.) User Centered System Design, pp. 87–124. LEA, Hillsdale (1986)
10. Jacoff, A., Messina, E., Weiss, B.A., Tadokoro, S., Nakagawa, Y.: Test Arenas and Performance Metrics for Urban Search and Rescue Robots. In: IEEE/RSJ International Conference (2003)
11. Johnson, J.: Children, Robotics, and Education. In: Artificial Life and Robotics, vol. 7, pp. 16–21 (2003)
12. Kitano, H., Tadokoro, S., Noda, I., Matsubara, H., Takahashi, T., Shinjou, A., Shimada, S.: Robocup Rescue: Search and Rescue in Large-Scale Disasters as a Domain for Autonomous Agents Research. In: Proceeding of IEEE Conference on Systems, Man, and Cybernetics, vol. 6, pp. 739–743 (1999)
13. Li, L., Chang, C., Chen, G.: Researches on Using Robots in Education. In: Chang, M., Kuo, R., Kinshuk, Chen, G.-D., Hirose, M. (eds.) Learning by Playing. LNCS, vol. 5670, pp. 479–482. Springer, Heidelberg (2009)

14. Lin, C., Liu, E.Z., Kou, C., Virnes, M.: A Case Analysis of Creative Spiral Instruction Model and Students' Creative Problem Solving performance in a LEGO Robotic Course. In: Chang, M., Kuo, R., Kinshuk, Chen, G.-D., Hirose, M. (eds.) Edutainment 2009. LNCS, vol. 5670, pp. 501–505. Springer, Heidelberg (2009)
15. Mikhak, B., Martin, F., Resnick, M., Berg, R., Silverman, B.: The Children's Machines: Handheld and Wearable Computers Too. In: Gellersen, H.-W. (ed.) HUC 1999. LNCS, vol. 1707, pp. 31–43. Springer, Heidelberg (1999)
16. Mitnik, R., Nussbaum, M., Soto, A.: An Autonomous Educational Mobile Robot Mediator. In: Autonomous Robot, vol. 25, pp. 367–382. Springer Science+Business Media, LLC, Heidelberg (2008)
17. Norman, D.: Cognitive Engineering. In: Norman, D., Draper, S.W. (eds.) User Centered Systems Design, pp. 31–62. LEA, Hillsdale (1986)
18. Papert, S.: Mindstorms: Children, Computers, and Powerful Ideas. Basic Book, New York (1980)
19. Papert, S.: Constructionism: A New Opportunity for Elementary Science Education. MIT: Media Laboratory-Epistemology and learning group, Cambridge (1986)
20. Papert, S.: The Children's Machine: Rethinking School in the Age of the Computer. Basic Book, New York (1993)
21. Quintana, C., Krajcik, J., Solloway, E.: Exploring a Structured Definition for Learner-centeredDesign. In: Fishman, B., O'Connor-Divelbiss, S. (eds.) Fourth International Conference of the Learning Sciences, pp. 256–263. Lawrence Erlbaum Associates, Hillsdale (2000)
22. Resnick, M., Ocko, S.: LEGO/Logo: Learning Through and About Design. In: Harel, I., Papert, S. (eds.) Constructionism. Ablex Publishing, Norwood (1991)
23. RoboCupJunior, `http://rcj.robocup.org/`
24. Slangen, L., van Keulen, H., Gravemeijer, K.: What Pupils Can Learn from Working with Robotic Direct Manipulation Environment. International Journal of Technology Des Education, Springerlink (2010)

Learning Robots: Teaching Design Students in Integrating Intelligence

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Abstract. The present day society requires specialists with multidisciplinary knowledge and skills. We discuss the possibilities to educate professionals that design intelligent products and systems as a result of a competency based education. In particular this paper features a teaching method that makes the students use intelligent algorithms that control robot behavior in a way that the robot can solve design problems with practical relevance, and reach human to machine interaction that includes machine intelligence. The outcomes of 14 cases done over 4 years showed that most students were able to integrate the required competencies in a synergistic way. Within 80 hours they could master the technical complexity of controlling a robot through a neural learning algorithm in well-grounded design cases.

Keywords: competency based learning, learning algorithms, behavioral robotics, adaptive design applications.

1 Introduction

Societal, scientific and technological developments are changing the field of industrial design. The field expands towards designing for intelligent systems, products and related services. If one truly likes to design systems that express intelligence in societally meaningful way, we believe that it implies a novel view on education that prepares specialists that can use skills and knowledge from different disciplines in a synergistic manner. The Department of Industrial Design, Eindhoven University of Technology, has been developing an educational program that will meet this challenge. In order to do so, the department offers a self-directed, competency-centered education model, including both: competency framework and the reflective transformative design process, in which learning and creating come together. We facilitate the learning process to let the students develop the ability to deal creatively and flexibly with the large amounts of constantly evolving information in globalized knowledge economy [1-4].

Designing embodied intelligent products is a contemporary challenge which deserves more attention and better support by novel methods and tools. For a long time the worlds of artificial embodied intelligence (represented by behavioral robotics) and industrial design developed separately. The intelligent objects were not developed to

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be used by real users, they were merely a research playground. In addition, behavioral robotics was mostly occupied with constitutive aspects of autonomy, such as collision avoidance, search for energy sources, and survival, and barely with interaction with humans. Examples of products that have embodied intelligence are robotic vacuum cleaners and grass trimming machines. In contrast, the industrial designers had to give high priority to interaction and usability, to emotional associations, styling, appeal, and even fun associated with the product. At present, the need for embodied intelligence features becomes apparent in many everyday personal objects and as a consequence, the two disciplines are merging. At the methodological level however, much work regarding their integration remains to be done [5].

The competency based learning framework gives equal weight to knowledge, skills and attitudes. Differently from the traditional studies, the knowledge, skills and attitudes are integrated already during the university education. This integration requires a powerful and rich learning environment. The student has to learn how to model contexts of use, how to actively explore concepts, how to evaluate alternative solutions, how to bring new artifacts into the world, in other words, how to design. This learning model appears not only to be well-accepted for traditional industrial design, where the material form of things is the central theme, but also to be effective for the aspects of industrial design that is concerned with creation of dynamic form (i.e. when the behavior of the product is designed on many levels).

Facing these challenges, this paper features a teaching method that makes the students combine artificial intelligence methods, in particular neural learning algorithms, to solve design problems. First, in the competency based educational system that aims at specialists with balanced knowledge of the modern technologies, user-centered design, design of business processes and conventional design education are combined. Second, we chose the very core of this education – designing of intelligent products and explore the importance of concepts such as embodiment, emergence, interactivity and learning within meaningful design applications. We analyze the outcomes of fourteen projects and show what the drawbacks are in the teaching process, in attempt to find new recommendations of how to prepare students for complex and multidisciplinary realities of the future.

2 Technology and Intelligence in Competency Based Learning

2.1 Competence Framework

At our department, the competency based learning framework includes ten specific competency areas that are involved during designing, related to the content of the system, product or service to be designed, and/or to the approach needed for the act of designing or becoming a designer [3, 4]. These ten competency areas are: 1) self-directed and continuous learning, 2) descriptive and mathematical modeling, 3) Integrating technology, 4) ideas and concepts, 5) form and senses, 6) user focus and perspective, 7) social and cultural awareness, 8) designing business processes, 9) design and research processes, 10) teamwork and communication. In this framework,

- *Self-Directed and Continuous Learning* is about taking responsibility for and give direction to your own personal development, based on a continuous process of self-reflection and out of curiosity for future developments in technology and society;
- *Descriptive and Mathematical Modeling* is about being able to create and apply models by using formal and mathematical tools, in order to justify design decisions and support the design of complex, highly dynamic and intelligent systems;
- *Integrating Technology* is about being competent in exploring, visualizing, creating and demonstrating innovative concepts and experiences using technology, as well as analyzing the technical and economic feasibility of complex designs in which technology is integrated. Moreover, one needs to understand scientific papers and be able to communicate with engineers and researchers of another disciplines;
- *Ideas and Concepts* is about developing visions, innovative ideas and concepts through creativity techniques, experimentations and the translation of research.
- *Form and Senses* is about Experiencing and developing through doing and abstraction, aesthetical (physical) languages that connect thought and interactive form, in order to communicate specific properties of the design concept.

The aim of the study is to make the students develop these competencies in a synergistic way: the students have to not only gain proficiency in the separate competency, but to integrate them into a novel quality. Integration is done through practically oriented activities such as projects and assignments in which equal weight is given to knowledge, skills and attitudes, and stimulates students to learn by doing [3, 4]. It is about learning and performing through practical application, while simultaneously acquiring theoretical skills, to the level that the students are participating in the research of the department. Both aspects are bridged through reflection on the taken actions. This approach fits the profession of industrial designer perfectly. Consequently, the design process we offer the students should be holistic and give equal weight to knowledge, skills and attitudes throughout the process and stimulate reflection.

2.2 Course Design

Designing intelligent products involves creation and interpretation of meanings through form and behavior. Apart from functional aspects of meanings there are very important non-functional aspects such as creating affordances, contexts and experiences [6]. There are *static* as well as *dynamic* aspects that facilitate affordances, contexts and experiences creation. While *static* refers to the form, shape, material, color and texture of the artifact, d*ynamic* refers to behavior, in other words, the movement, light and sound, and the changes of form, shape, material, color and texture that take place over time. All the mentioned aspects are, however, non-separable, which can very well be explained with the notion of embodiment. In the past few decades there was a converging interest in embodiment from scholars in philosophy, cognitive science, psychology, linguistics, robotics, and neuroscience. Embodiment signifies that the static or physical aspects of the product determine and provoke bodily interactions with the surrounding world. For simple products these interactions are rather passive and simple to anticipate. However, nowadays products are starting to behave, have autonomy, intelligence, and even emotions [7-13].

To cope with these novel requirements of the product design we have introduced a multidisciplinary course called Learning robots that focuses on usage of brain-inspired learning algorithms, implemented on an embodied agent (robot or a tangible interaction tool) within an interaction design task. In terms of the competence based educational system, the following competencies were addressed: integrating technology, that accounts for the technical implementation of the learning algorithms on embodied agents; mathematical modeling that embeds the learning process within the selected design task; form and senses, for designing the particular embodiment, the behavior, and the interaction patterns of the robots.

The tools and platforms used within this course were a selected set of learning algorithms that were implemented on Matlab and explained to the students on the level of concept, working and implementation. Two robotic platforms, namely AdMoVeo robot [14] and i-blocks [15] were used as a platforms to develop interaction behaviors and Neuroph neural learning engine was provided [18].

2.3 Embodiment: AdMoVeo Robot

To teach the students learning algorithms and programing skills, the focus shall not be distracted by form giving and embodiment. Using robots in this context has been a positive experience in our teaching practice [5, 16]. The AdMoVeo robot (Fig. 1) is designed especially for this purpose [14, 17].

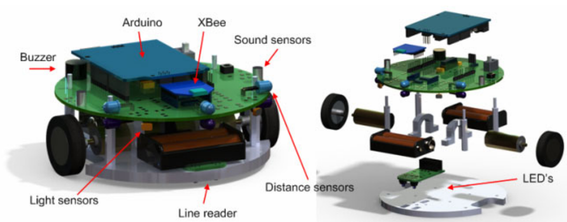

Fig. 1. 3D rendering of the AdMoVeo robot

The design of AdMoVeo features a detachable Arduino Diecimila board and two wheels integrated within the round shape of the chassis. The chassis and motor mount are made from transparent acryl glass, giving it a see-through look into everything inside. The sensors include two line readers at the bottom, three infrared distance sensors at the sides and in the front with sensibility of 0 to 20cm, two light sensors in the front, two sound sensors at the sides and two optional encoders coupled to wheels. The actuators include two motors driving two wheels, a buzzer and a RGB color LED integrated into the acryl chassis. An XBee module is optional for wireless communication. The software design is based on a layered structure of composition and inheritance. It has mainly two major parts: the firmware *IDuino* running in the Arduino microcontroller of the AdMoVeo robot, and the Java API library for programming and controlling AdMoVeo in the Processing programming environment [17]. Processing is an open source programming language and environment widely used by artists, designers and researchers to program images, animation, and interactions.

To easily implementing some of the learning algorithms and interfacing with the AdMoVeo robot through Java-based Processing, students were encouraged to use Neuroph[1], a lightweight Java neural network framework [18]. Some groups used MATLAB.

3 Design Cases

During 4 years 14 groups of 3 to 4 students were working on different design cases. The students were thought 3 different learning paradigms and possible applications were discussed and demonstrated for each algorithm. The students were introduced to the robotic platforms and they also could choose to make an own platform. Each hardware platform had to perform an intelligent behavior caused by a learning algorithm. The behaviors had to be a solution to a design case in which learning will be of true added value. In the following subsections we introduce 2 outcomes of student's modules that serve as an illustration for the analysis of the overall outcomes of this learning activity with respect to competencies development and integration.

3.1 Training Robot Dog

In this design case a robot was trained as a pet-dog that is rewarded for accomplishing of a meaningful action. In this case the advanced interaction possibilities between a robot and a human were addressed. The complexity of this task comes from the definition of "meaningful" action. An action that is meaningful to human usually consists of more than one simple action. Simple action is known in behavioral robotics as action or movement primitive, and a typical reinforcement learning algorithm could easily learn to reward such primitives. In the case of a meaningful action, the reinforcement has to come after different number of primitive actions.

The experimental setting consisted of 2 steps. First, supervised learning was used for the recognition of spoken commands that give order to the robot dog. And second, the Q-learning algorithm was used to encourage the performed action sequences. Initially the robot responds to a voice command with a random action. The action was rewarded or punished each time by the user and the robot remembered the association between a reward and a meaningful action. Next time the robot hears the command it will try to perform the proper action to receive a reward.

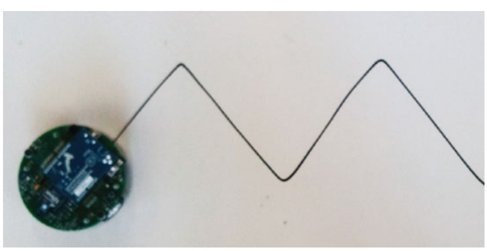

Fig. 2. Design case: training a robot dog

[1] neuroph.sourceforge.net

3.2 Fashion Business

The Fashion business case features a robot assistant that consisted from the AdMoVeo robot, augmented with a web camera that is able to guide people through a clothing store and to suggest clothing that fits them (Fig. 3). The robot was able to dynamically adapt towards new clothing in a shop, analyze customers clothing and learn to give appropriate suggestions from feedback of the customers. The robot was designed to use a feedback from the color of the item that the previous customers bought and to link that with the clothing used by these customers. Information from different customers was continuously updated with the aim that the robot also can recognize for example the most popular clothing.

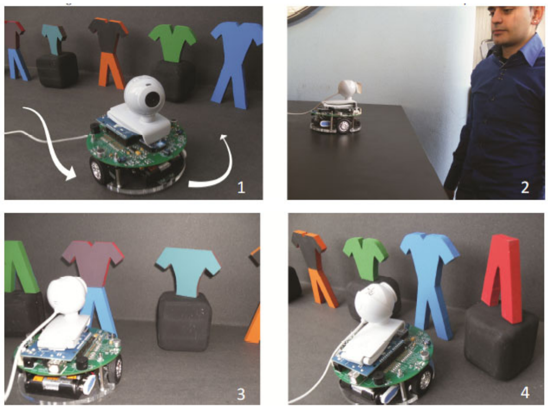

Fig. 3. Design case: Fashion business

Behavioral scenario consisted from two phases. First, the robot explored the shop to identify different available colors of clothing. The neural gas algorithm that uses a number of predefined classes was used for this application. With this algorithm several classes where created on the basis of RGB values of different captured colors. After training the classes were fixed.

In the second phase, (Fig. 3, capture 2), a new customer enters the shop. The average color of his/her clothes is captures and translated into RGB values, which serve as an input to the learning algorithm which classifies it to the clusters of colors that were fixed at phase one. The robot will then be able to make suggestions according to the colors that a customer is wearing.

Within the time span of 60 to 80 hours the students were able to either create a good design framework and interaction scenarios and partially working solution, as in Design case 2, or to make well working application with a hypothetical real life application, as in the Design case 1. Three groups made their own hardware platform and controlled it with a learning algorithm to express an intelligent behavior. One group used the existing i-blocks, and 9 groups used AdMoVeo robot, and one group presented advanced computer simulation and a game design concept which were not integrated. Overall the three competencies were integrated within a coherent outcome. A single competency was dominant in each group. This depended on the learning goals of the students within the group. Moreover, students with similar level of development of their competency profiles and proficiency tended to work together in a group.

4 Discussion

This paper presents our practical experience with applying the competency based learning to educational topics that required multidisciplinary knowledge and skill development. There were three relatively complex tasks that had to be integrated in this module: original design concept, proficiency with using robotic hardware platform and creation of intelligent behavior of this platform within the design context. The outcomes over 4 years and 14 projects showed that the integration of the competencies that were needed for each design case, namely idea generation, integrating technology, form and senses, and mathematical and descriptive modeling were integrated in a synergistic way in most of the design cases outcomes. The few cases that lacked either strong real-life design application or working learning behaviors were due to too ambitious task choices.

Comparing these achievements with students that made long-term master projects on behavioral robotics within traditionally set education system, we found out that the abilities of the students educated within the competency based system differ with their determination to accomplish a societally meaningful and working application. Our master students can combine and use knowledge from several different disciplines in a synergistic and practically meaningful way. Sensing the new realities, gradually more students join ID education than traditional robotics related studies.

References

1. Hummels, C., Frens, J.: Designing for the unknown: A design process for the future generation of highly interactive systems and products 4, 204–209 (2008)
2. Hummels, C., Frens, J.: The reflective transformative design process. In: CHI 2009, pp. 2655–2658. ACM, Boston (2009)
3. Hummels, C., Vinke, D.: Eindhoven Designs, vol. 2. Eindhoven University of Technology, Edinhoven (2009)
4. Hummels, C., Vinke, D., Frens, J., Hu, J.: Competency-centered Education for Designing Interactive and Intelligent Products. Creation and Desion (to appear, 2011)
5. van der Vlist, B., van de Westelaken, R., Bartneck, C., Hu, J., Ahn, R., Barakova, E., Delbressine, F., Feijs, L.: Teaching Machine Learning to Design Students. In: Pan, Z., Zhang, X., El Rhalibi, A., Woo, W., Li, Y. (eds.) Edutainment 2008. LNCS, vol. 5093, pp. 206–217. Springer, Heidelberg (2008)
6. Feijs, L.M.G., Barakova, E.I.: Semantics through embodiment: a non-linear dynamics approach to affective design. In: Feijs, L., Kyffin, S., Yong, B. (eds.) Design and Semantics of Form and Movement, pp. 108–116 (2007)
7. Barakova, E.I.: Emergent behaviours based on episodic encoding and familiarity driven retrieval. In: Bussler, C.J., Fensel, D. (eds.) AIMSA 2004. LNCS (LNAI), vol. 3192, pp. 188–197. Springer, Heidelberg (2004)

8. Barakova, E., Lourens, T.: Expressing and interpreting emotional movements in social games with robots. Personal and Ubiquitous Computing 14, 457–467 (2010)
9. Barakova, E.I., Vanderelst, D.: From spreading of behavior to dyadic interaction - A robot learns what to imitate. International Journal of Intelligent Systems 26, 228–245 (2011)
10. Lourens, T., Barakova, E.: My Sparring Partner Is a Humanoid Robot. In: Mira, J., Ferrández, J., Álvarez, J., de la Paz, F., Toledo, F. (eds.) IWINAC 2009. LNCS, vol. 5602, pp. 344–352. Springer, Heidelberg (2009)
11. ten Bhömer, M., van der Aalst, K., Barakova, E., Ross, P.: Product adaptivity through movement analysis: the case of the intelligent walk-in closet. In: Proceedings of Design and Semantics of Form and Movement (DeSForM 2009), pp. 114–121. Koninklijke Philips Design, Taipei (2009)
12. Barakova, E.I.: Social interaction in robotic agents emulating the mirror neuron function. In: Mira, J., Álvarez, J.R. (eds.) IWINAC 2007. LNCS, vol. 4528, pp. 389–398. Springer, Heidelberg (2007)
13. Abraham, A., Jónyer, I., Barakova, E.I., Jain, R., Jain, L.: Special issue on hybrid neurocomputing. Neurocomputing 61, 1–3 (2004)
14. Hu, J., Alers, S.: AdMoVeo: Created For Teaching Creative Programming. In: Hirashima, T., Mohd Ayub, A.F., Kwok, L.-F., Wong, S.L., Kong, S.C., Yu, F.-Y. (eds.) Workshop Proceedings of the 18th International Conference on Computers in Education (ICCE 2010), pp. 361–365. Universiti Putra Malaysia, Malaysia (2010)
15. Alers, S., Barakova, E.I.: Multi-agent platform for development of educational games for children with autism. In: Games Innovations Conference, ICE-GIC 2009, pp. 47–53. International IEEE Consumer Electronics Society’s (2009)
16. Bartneck, C., Hu, J.: Rapid Prototyping for Interactive Robots. In: The 8th Conference on Intelligent Autonomous Systems (IAS-8), pp. 136–145. IOS press, Amsterdam (2004)
17. Alers, S., Hu, J.: AdMoVeo: A Robotic Platform for Teaching Creative Programming to Designers. In: Chang, M., Kuo, R., Kinshuk, Chen, G.-D., Hirose, M. (eds.) Learning by Playing. LNCS, vol. 5670, pp. 410–421. Springer, Heidelberg (2009)
18. Sevarac, Z.: Neuro fuzzy reasoner for student modeling. In: Sixth International Conference on Advanced Learning Technologies, pp. 740–744. IEEE, Los Alamitos (2006)

Applying ARCS Model for Enhancing and Sustaining Learning Motivation in Using Robot as Teaching Assistant

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Abstract. Although many researchers have pointed out that educational robots can stimulate learners' learning motivation, learning motivation will be inevitably decreased over time if the amusement just came from the new technology itself. Accordingly, learners must be well guided by suitable instructional strategies to gain the enhancement and sustainability of the learning motivation. In other words, it still requires adopting suitable instructional strategies so as to enhance and sustain their learning motivation even if introducing educational robots to learners can stimulate learning motivation at the beginning. This paper presents a preliminary experiment result to explore if the instructional strategy of integrating robot teaching assistant (RTA) with ARCS model can enhance and sustain learning motivation. The result from the pilot experiment showed that the test group learners had potential to outperform the control group learners in terms of enhancement and sustainability of learning motivation and learning performance.

Keywords: Robot Teaching Assistant (RTA), ARCS Model, Sustainability of Learning Motivation, Learning Motivation Polyline Graph (LMPG).

1 Introduction

Learning motivation is the origin of incurring learning [1], it is also an important index for evaluating learning performance [2]. Strong learning motivation can promote learning and then improve learning performance [3]. The extrinsic and intrinsic motivations are two types of learning motivations. Some researchers thought learners will be motivated to learn by external influences in the learning context. However, some other researchers thought that learning motivation is an intrinsic enforcement, that is to say learners will be motivated to learning if they perceive there is a need such as Maslow's [4] hierarchy of needs. Maehr [5] defined continuing motivation (i.e., intrinsic motivation) as the tendency of a learner would like to return for continuing learning after completing a learning session. This study argues that both extrinsic and intrinsic motivations are very important. However, learning motivation

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will change with the learning progress over time [6]. In addition to enhance learners' learning motivation, to pay attention on enhancing the sustainability of learning motivation is even more important [7].

Recently, there are many educational robots which being introduced in teaching and learning contexts. Some assisted educational robots can help learners better understanding learning materials [8]. As robots are tangible objects, they can provide learners with high interactivity and joyful learning experiences [9] by using gestures or body movements to express some simple concepts. Learners will become more active in learning as a result of the enhancement of learning motivation from educational robots [8]. However, the learning motivation promoted by educational robots will be degraded along the time passed by if there is no instructional strategy in place [10]. Many researchers had pointed out that learners' promoted learning motivation cannot be sustained when applying educational robots in education without a suitable learning strategy [11]. Keller [12] proposed the ARCS model which can be applied to design strategies for promoting learning motivation by analyzing learners' motivational needs and characteristics so as to improve instructional quality and to sustain learning motivation [13]. The aim of this study was to design a robot teaching assistant (RTA) by combining the unique features of a humanoid robot, such as the movement, the body gesture and the interactivity, with the ARCS model in designing a more suitable instructional strategy for enhancing and sustaining learning motivation.

2 The Design of Instructional Strategies and the System

While designing the RTA, the ARCS model was adopted as the guided instructional strategy. Besides, this study also adopted the Joyful Classroom Learning System (JCLS) [14] to support the learning activity during the experiments.

2.1 The Four Elements of the ARCS Model

The importance of this attention element is how to attract learner's attention and sustain it, Ours study refers to the strategies proposed by Visser & Keller [15] for attracting learner's attention. The first step is to attract learners with new stuffs like special design teaching aids and body actions. As humanoid robot is new to learners and can perform body actions, it was the reason why we adopted humanoid robot to build a teaching assistant to attract and guide learners (Fig. 1). Once learner's attention is being attracted, the next step is to stimulate learner's curiosity; asking relevant questions are used to stimulate learning desires. Some questions are designed and relevant to learning goals to provide interactive Q&A learning activities for learners by using the RTA (Fig. 2(a)). When the time passes by and learners' attention might be degraded, Keller [16] suggested to randomly use different types and different strengths of stimulates to recover or sustain learners' attention and three types of random rewards for this purpose in this study. When a learner got a correct answer, the system will randomly provide a reward to the student from one of three types of item cards, Dice, Classmate and Angel shown in the random rewards area (Fig. 2(a)) and use it in group contest (Fig. 2(b)). In addition, the RTA also varied facial expressions and hand movements to strengthen and maintain learner's attention in a learning activity.

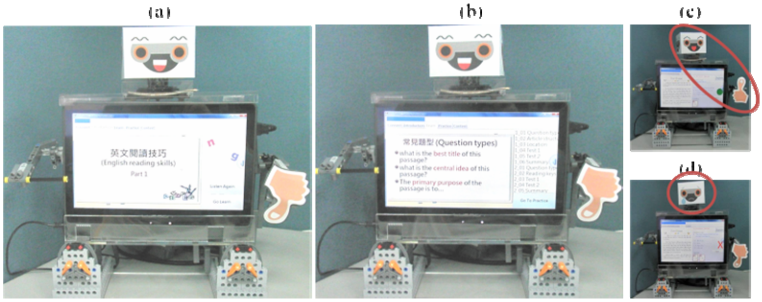

Fig. 1. RTA (a) Learning goal (b) Learning materials (c) Correct answer (d) Wrong answer

The importance of this relevance element is to let learners be aware of the knowledge and skills to be learnt are really related to themselves and useful. Bandura and Schunk [17] suggested that providing multiple short-term goals are much easier to stimulate learning motivation than just one long-term goal, it is also making learners be more concentrated [18]. This study then created multiple sub goals for leading learners to achieve the final goal. Keller [16] also suggested that making learning progress visible can make learners understand their learning progress better and feel the learning are relevant to them. The progress bar is a concrete implementation in this study to make learners being in control of their learning progress and being tighten with the learning process (Fig. 2(a)). In addition to goal setting, learners also have the needs for friendships and responsibilities from their learning peers [16]. The learners were divided into several groups for team-based collaborative learning to fulfill the needs in this study. Each individual learner must try their best to perform what they have learnt and also to help others in order to fulfill the personal and group responsibilities. The RTA is also treated as a team member and it will also provide required assistance to group members. Finally, Keller [16] suggested using authentic case studies which are related to learners' real life experiences to ease of comprehension about new concepts. This study utilized some real-life case studies which are related to learning topics to guide learners delivered by the robot teaching assistant (Fig. 2(a)).

The confidence is the most important factor affecting learners in doing persistent learning [6], so we help learners' to build and gain self-confidence. Firstly, how to make learners believe that if they follow the learning guidance, they will be reaching the learning goal, Keller [16] suggested using checkpoint questions to achieve the purpose. In this study, the checkpoint questions are designed to act as a guiding facilitator through the use of learning goals and interactive Q&As (Fig. 2(a)). In addition to giving guidance, Keller [16] also suggested to provide immediately positive feedback when learners got a correct answer so as to enforce learners' confidence in believing themselves having the ability to achieve the learning goal. A prompt windows is designed to server this purpose. The checkpoint questions are designed to provide learners the opportunities for self-evaluation practices, the RTA will show thumb-up when a learner got a correct answer (Fig. 1(c)). For those cases, which learners did not get correct answers (Fig. 1(d)), the system also provides positive encouragements and concrete explanations in order to help learners building confidence (Fig. 2(a)).

When learners can perceive their effort is matching with their outcome, they will be proactive in doing continuous learning. The importance of this satisfaction element is to help learners be assured their learning performance. Keller [16] suggested to create a scenario where learners can immediately apply what their have learnt in solving problems so as to create learning satisfaction. In this study, a group contest was designed to serve this purpose. Keller [16] also suggested giving learners positive feedbacks no matter how they performed. The RTA will give a positive reward if learners got a correct answer, and give a positive encouragement if learners got a wrong answer. For the sake of fairness, Adams [19] proposed the equity theory in which learners will be aligned at the same initial point to reduce their feeling of unfairness. At the beginning of the experiment, learners will be introduced clearly about all the rules and if they are willing to try their best in learning, they will receive corresponding rewards (Fig. 2(b)).

Fig. 2. (a) Case study practice (b) Group contest

2.2 The Designs for the Test Group and Control Group

In summary, the instructional strategies of the RTA integrated with ARCS model (i.e., test group) can be divided into three stages. The first stage is explaining learning goal (Fig. 1(a)) and learning materials (Fig. 1(b)) to fulfill the purposes of attracting learners' attention, articulating learners with learning goal and letting all learners at the same initial point. The successive experimental steps about the functions of the RTA are the use of catching the eye sights of learners, setting multiple sub goals to achieve the final goal, using visible progress bar. The second stage is to adopt case studies for practices (Fig. 2(a)), firstly learners will be immersed in specific learning scenario and then to satisfy the needs of their learning motivation, finally is to help learners achieving the learning goal. The real-life case studies s, interactive Q&As, random rewards, checkpoint questions and tooltips are all included in this stage. The third stage is to conduct competition (Fig. 2(a)), this is to let learners create satisfaction through positive feedback from the practices in the group contest so as to maintain higher learning motivation for continuing learning. The learning activities designed for the control group are common functions such as the robotic movement [20], conversations, and simple feedback [14]. All designed functions in the control group are the union set based on prior literatures this study reviewed.

3 Research Methodology

This paper presents a preliminary experiment result, which is to explore if the instructional strategy of integrating RTA with ARCS model can enhance and sustain learning motivation, the research framework is shown in Fig. 3(a). The learning topics used for the experiment are English reading skills including skill for finding the key sentences about the main idea and its essential information, skill for figuring out the meanings of unfamiliar words, and skill for summarizing the article [21]. The test group and control group are conducted by the same instructor. All participants will be guided to complete the prior test, the post test and the Instructional Material Motivational Survey (IMMS) for evaluating their learning performance and learning motivations.

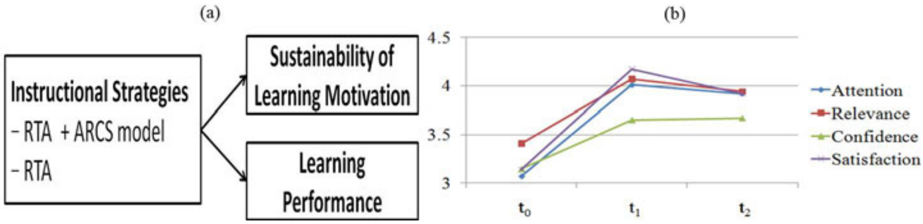

Fig. 3. (a) Research model (b) Learning motivation polyline graph

As Fig. 4, learners are asked to complete the prior tests including IMMS and learning performance before the experiment (t_0). In the first experiment (t_1) and the second experiment (t_2), learners will learn reading skills, and they will received instructional strategies depended on the test group and control group. The test group is provided the RTA integrated with ARCS model based on the design described in the prior "System Design" section. The control group is provided only the RTA. The RTA designed for the control group is as described in the previous section. The IMMS was modified from Keller [16] and used to assess learners' motivations at the beginning of the experiment and right after two instructional experiments (t_0, t_1 and t_2). Based on the IMMS results, a Learning Motivation Polyline Graph (LMPG), which is s adopted the learning curve concept from Wright [22], can be plotted to show the learning motivation changing tendency. If the slope of any two points is positive which implies the tendency of the learner's learning motivation is increasing, on the other hand if the slope of ant two points is negative which implies the tendency of the learner's learning motivation is decreasing. There are 36 items in total in the developed questionnaire, all items are used the Likert five point scale. For data analysis, independent sample t test will be used to analyze the sustainability of learning motivation and learning performance between the test group and the control group.

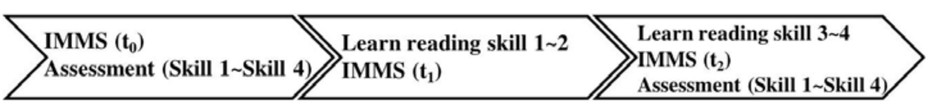

Fig. 4. Experimental procedure for Pilot Experiment

4 Results of the Pilot Experiment

A pilot experiment was conducted before the formal experiment; six second year postgraduate students (3 male and 3 female) were recruited to participate in the experiment. Before the experiment (t_0), learners were asked to do the prior tests. To assess the change rate in learning motivation, which were evaluated using IMMS right after the first experiment (t_1) and the second experiment (t_2). There were four days separated between the two experiments. After the learners had completed the learning for reading skills 1~4, learners were asked to do the posttest for learning performance. The results showed that learners' learning performance only had a little improvement from prior test (Mean = 2.8, SD = 0.75) to posttest (Mean = 3.2, SD = 1.47). The reason might be the duration of the experiment was not long enough to allow learners to be experienced with all the four reading skills as reading ability required repeated practices over a period of time [23]. For the learning motivation, the results (Table 1) showed that learners had a great improvement in their learning motivation after the first experiment (t_1). Then, the result after the second experiment (t_2) only had a small decrement in learning motivation, but still had a better improvement than original learning motivation (t_0). This result implies the designed instructional strategy of robot teaching assistant integrated with the ARCS model can be used for sustaining learning motivation.

The following results were examined in more details from four elements of the ARCS model. According to the results (Fig. 3(b)), all ARCS elements were improved after learners participated the first learning experiment (i.e., from t_0 to t_1). Then, learners' perceptions about all ARCS elements slightly descended after learners participated the last learning experiment (i.e., from t_1 to t_2). This descending trend represented a minor slop on the polyline between t1 to t_2. For the attention element, it was observed during the experiment that learners expressed a high curiosity toward the RTA by touching the foot and the head of the robot. This showed the RTA can draw learners' attention to be engaged in the learning process. Besides, it was also observed that learners were concentrating on watching the RTA screen especially learners paid much attention on what types of reward cards they will get when RTA is showing the random awards. Regarding to the relevance element, this pilot experiment provided many examples to learners for explanations and practices, especially the group discussion which made learners more clearly understand the importance of English reading skill and hence helping learners to comprehend the learning content. Compared with the attention element, lower intensity of enhancement was shown in the relevance element. During the learning process, this pilot experiment observed that learners were all behaved positively and enthusiastically in terms of concentrated thinking, discussions, and practices. For the confidence element, the confidence of learners indeed improved over time with the RTA's clear explanation for the ambiguous question or false answer although the increasing extent was in a slow accumulation progress. For example, the checkpoint questions helped learners to review their learning status and to revise what they just learnt while having a wrong answer. Regarding to the satisfaction element, the results show a consistency on how much learners were engaged in the learning activity. Based on the observation result, most learners minded a lot about if they had answered a question correctly. Accordingly, the positive feedback from RTA played a vital role on motivating them to keep learning.

In the competition stage, a winning group expressed extremely excited behavior by screaming loudly. It shows the designed RTA with ARCS model had potential to improve and maintain learning motivation. Two problems were found in the pilot experiment, suggestions for improvement or remedy are proposed. The first one was learners' attention had a little bit drop after the second experiment, it is suggested to design different types of facial expressions or outlooks for RTA so as to maintain learners' attention in each different runs. The second problem was not enough time to comprehend learning materials, it is suggested to conduct one more experiment for remedy this issue.

Table 1. Learning motivations

Time	Attention	Relevance	Confidence	Satisfaction	Mean	SD
t_0	3.07	3.41	3.15	3.14	3.17	0.45
t_1	4.01	4.07	3.65	4.17	3.98	0.44
t_2	3.92	3.94	3.67	3.92	3.84	0.41

5 Conclusions

The application of educational robots can stimulate learners' learning motivation; however, learning motivation will be inevitably decreased over time if the amusement just came from the new technology itself. This study has designed a robot teaching assistant (RTA) by adopting the ARCS model as the instructional strategies for sustaining learning motivation. The results showed that the RTA with ARCS model had potential to improve and maintain learning motivation. Nevertheless, learners are expected to perform better on learning performance once the sustainability of learning motivation can be sustained. For future study, this study is conducting a formal experiment with a larger number of participants, which is expected to recruit more than 60 learners, for a robust statistical analysis.

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References

1. Weiner, B.: An attributional theory of achievement motivation and emotion. Psychological Review 92, 548–573 (1985)
2. Small, R.V., Gluck, M.: The Relationship of Motivational Conditions to Effective Instructional. Educational Techology 36, 33–40 (1994)
3. Viljaranta, J., Lerkkanen, M.K., Poikkeus, A.M., Aunolaa, K., Nurmia, J.E.: Cross-Lagged Relations between Task Motivation and Performance in Arithmetic and Literacy in Kindergarten. Learning and Instruction 19, 335–344 (2009)
4. Maslow, A.H.: A theory of human motivation. Psychological Review 50, 370–396 (1943)
5. Maehr, M.L.: Continuing Motivation: An Analysis of a Seldom Considered Educational Outcome. Review of Educational Research 46, 443–462 (1976)

6. Keller, J.M.: The Systematic Process of Motivational Design. Performance & Instruction 26, 1–8 (1987)
7. McDonald, A.: Keeping the vision alive: Maintaining motivation and promoting effective learning. Procedia - Social and Behavioral Sciences 3, 190–193 (2010)
8. Mitnik, R., Recabarren, M., Nussbaum, M., Soto, A.: Collaborative robotic instruction: A graph teaching experience. Computers & Education 53, 330–342 (2009)
9. Shinozawa, K., Naya, F., Yamato, J., Kogure, K.: Differences in effect of robot and screen agent recommendations on human decision-making. International Journal of Human-Computer Studies 62, 267–279 (2005)
10. Li, L.Y., Chang, C.W., Chen, G.D.: Researches on Using Robots in Education. In: Conference Researches on Using Robots in Education, pp. 479–482. Springer, Heidelberg (2009)
11. Liu, E.Z.F., Kou, C.H., Lin, C.H., Cheng, S.S., Chen, W.T.: Developing multimedia instructional material for robotics education. Wseas Transactions on Communications (WTOC) 7, 1102–1111 (2008)
12. Keller, J.M.: Motivational design of instruction. In: Regality, C.M. (ed.) Instructional-design theories and models: An overview of their current status, pp. 386–434. Lawrence Erlbaum Association, Hillsdale (1983)
13. Keller, J.M., Koop, T.: An application of the ARCS model of motivational design. In: Reigeluth, C. (ed.) Instructional Theories in Action: Lessons Illustrating Selected Theories and Models. Lawerence Erlbaum, Hillsdale (1987)
14. Wei, C.W., Hung, I.C., Lee, L., Chen, N.S.: A Joyful Classroom Learning System with Robot Learning Companion for Children to Learn Mathematics Multiplication. Turkish Online Journal of Educational Technology 10, 11–23 (2011)
15. Visser, J., Keller, J.M.: The Clinical Use of Motivational Messages: An Inquiry into the Validity of the ARCS Model of Motivational Design. Instructional Science 19, 467–500 (1990)
16. Keller, J.M.: Motivational Design for Learning and Performance: The ARCS Model Approach. Springer, New York (2010)
17. Bandura, A., Schunk, D.H.: Cultivating competence, self-efficacy, and intrinsic interest through proximal self-motivation. Journal of Personality and Social Psychology 4, 586–598 (1981)
18. Reeve, J.: Understanding motivation and emotion. Wiley, Hoboken (2005)
19. Adams, J.S.: Towards an understanding of inequity. Journal of Abnormal and Social Psychology 67, 422–436 (1963)
20. Barker, B.S., Ansorge, J.: Robotics as Means to Increase Achievement Scores in an Informal Learning Environment. Journal of Research on Technology in Education 39, 229–243 (2007)
21. Reier, J.: McGraw-Hill's GED Language Arts. McGraw-Hill, Reading (2002)
22. Wright, T.P.: Factors Affecting the Cost of Airplanes. Journal of Aeronautical Sciences 3, 122–128 (1936)
23. Schwanenflugel, P.J., Kuhn, M.R., Morris, R.D., Morrow, L.M., Meisinger, E.B., Woo, D.G., Quirk, M., Sevcik, R.: Insights into Fluency Instruction: Short- and Long-Term Effects of Two Reading Programs Literacy Research and Instruction 48, 318–336 (2009)

An Investigation of Using Educational Toys into Science Instruction for 4th Graders

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Abstract. The purpose of this study is to investigate the learning outcomes of using educational toys into science instruction for 4th graders. A quasi-experimental design was used with 4 classes. The findings of this study include (1) students in the experimental group got higher scores than the control group did on the science achievement test and the scientific attitudes scale; (2) more than 90.2% of students in the experimental group had positive response on the study questionnaire. Therefore it can be concluded that science educational toys and competition is effective for 4th graders in this study.

Keywords: Educational toys, Science learning achievement, Science instruction, Scientific attitudes.

1 Introduction

The use of toys in science instruction is common. Using scientific toys into science instruction are not only very useful in lectures and demonstrations in order to motivate students but also very interesting from a scientific point of view [1-6]. Therefore science educational toys and competition activities will be used in this study.

2 Objectives

The major purpose of this study is to investigate the learning outcomes of using science educational toys and competition activities into science instruction for 4th graders in Taipei.

3 Methodology

There were 4 classes students (*N*=122) at a primary school in Taipei participated in this study. Two classes were assigned as the experimental group (*N*=61), and the others were the control group (*N*=61). Students in experimental group were given 5 weeks of science educational toys and competition activities into science instruction

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on the unit of "electric circuit", while the control group received traditional instruction. Three research instruments were used in this study include a science achievement test, a scientific attitudes scale, and a study questionnaire. The results were undergone by *ANCOVA* analysis.

4 Results and Discussion

4.1 Results from the Science Achievement Test

Learning outcomes on the science achievement test were collected, analyzed, and stated as following. There are 122 4th graders participated in this study. The learning outcomes of the science achievement test were presented on table 1 and 2.

Table 1. *Mean* and *SD* of science achievement test scores by groups

	N	Pre-test		Post-test	
		Mean	*SD*	*Mean*	*SD*
experimental group	61	13.46	3.837	21.13	4.436
control group	61	13.20	3.572	18.95	4.870

Table 2. *ANCOVA* of science achievement test scores by groups

source	*SS*	*df*	*MS*	*F*	*p*
Between	121.025	1	121.025	8.397	.004**
Error	1715.136	119	14.413		

The learning outcomes of the science achievement test indicate that students in the experimental group had a better learning performance than control group did (F= 8.397, $p < .01$).

4.2 Results from the Scientific Attitudes Scale

The learning outcomes of the scientific attitudes scale were presented on table 3 and 4.

Table 3. *Mean* and *SD* of scientific attitudes scale scores by groups

	N	Pre-test		Post-test	
		Mean	*SD*	*Mean*	*SD*
experimental group	61	116.34	15.383	120.36	14.263
control group	61	113.08	15.852	113.69	15.462

Table 4. *ANCOVA* of scientific attitudes scale scores by groups

source	*SS*	*df*	*MS*	*F*	*p*
Between	622.302	1	622.302	5.182	.025*
Error	14290.775	119	120.091		

The learning outcomes of the scientific attitudes scale indicate that students in the experimental group had a better learning performance than control group did (F= 5.182, $p < .05$).

4.3 Results from the Study Questionnaire

The learning feedbacks on the study questionnaire by experimental group were presented on table 5.

Table 5. Learning feedbacks on the study questionnaire by experimental group

	Strongly Agree		Agree		Dis-agree		Strongly Disagree	
	N	%	*N*	%	*N*	%	*N*	%
1. I prefer constructing science toys	41	67.2	16	26.2	2	3.3	2	3.3
2. I prefer science competitions	29	47.6	26	42.6	3	4.9	3	4.9
3. Science toys & competitions help me improving science learning	27	44.3	30	49.2	1	1.6	3	4.9

The learning feedbacks on the study questionnaire indicate that more than 90.2% of students in the experimental group had positive response on science educational toys and competition activities during their science learning. The analyses of the data also show that students love learning science by doing science educational toys and competitions project and that they wanted to do similar projects for other science units in the future.

5 Conclusion

The major findings of this study are summarized as the following: (1) the results of the science achievement test were that students in the experimental group got higher scores than students in the control group; (2) the results of the scientific attitudes scale were that students in the experimental group got higher scores than the control group did; (3) the learning feedbacks on the study questionnaire indicate that more than 90.2% of students in the experimental group had positive response on using educational toys and competition activities in their science learning. Therefore it can be concluded that science educational toys & competition activities is effective for 4th graders in this study.

References

1. Butta, J.L.: A comparison of traditional science instruction to hands-on science instruction. (ERIC ED436362) (1998)
2. Fisher, N., Gerdes, K., Logue, T., Smith, L., Zimmerman, I.: Improving students' knowledge and attitudes of science through the use of hands-on activities. (ERIC ED436352) (1998)

3. Guemez, J., Fiolhais, C., Fiolhais, M.: Toys in physics lectures and demonstrations–A brief review. Physics Education 44(1), 53–64 (2009)
4. Lai, C., Wang, C.: A study of science play instruction in conjunction with scientific toys for 5th graders. Research and Development in Science Education 56, 29–52 (2010)
5. Sarquis, J.L., Sarquis, A.M.: Toys in the classroom. Journal of Chemical Education 82(10), 1450–1453 (2005)
6. Stein, M., Miller, D.: Teaching with toys. Science Teacher 64(4), 22–25 (1997)

HuayuNavi: A Mobile Chinese Learning Application Based on Intelligent Character Recognition*

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Abstract. With the recent rise of China, Chinese is becoming a dominant language in the world. People are pursuing an efficient and effective means to learn the Chinese language. Most of the traditional learning platforms such as textbooks, laptop applications and language learning centers are not portable and interactive simultaneously. In this paper, we attempt to develop a new language-learning platform that not only creates a better user experience but also promotes better efficiency in language training. We present a mobile application named HuayuNavi that integrates a touch-based user interface with intelligent character recognition techniques to achieve real-time image content understanding. Specifically, the feature vector is formed by accumulating localized gradients of different orientations in the image. Recognition is achieved by employing support vector machine (SVM) with probability estimation to obtain candidate characters, which is then refined using domain-specific vocabulary models. The overall operation can be completed in 3 seconds. Initial tests on the specific subject of Taiwanese snacks indicate that the recognition rate can reach 83% using handwritten samples as well as signboards containing characters of diverse fonts.

Keywords: smartphone application, Chinese learning assistant, intelligent character recognition.

1 Introduction

Recently, smartphone is gaining huge popularity due to its portability, accessibility and multiple functionalities. Advances in human computer interaction, especially the multi-touch user interface, have helped to lower the bar for operating mobile devices. As witnessed and personally experienced by our generation, smartphones are gradually changing people's life style. From voice conversation in the early stage to the current expanding list of functions such as navigation, entertainment, and social interaction, smartphones have the potential to significantly transform the way we learn, explore and share information as well as feelings in the near future.

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In 2010, global smartphone shipments hit 295 million units [1]. Along with this trend came a vast number of mobile applications, or Apps, in several major platforms. Apps that provide add-on features to the smartphone are abundant. Educational or e-learning software is among one of the many popular categories in these App store or markets. Compared with traditional tools, mobile e-learning applications can be made more interesting thanks to the multimedia capabilities of current hardware devices. Context-awareness can further enhance the learning experience by incorporating useful contextual information such as time, location or personal profile.

Within the category of educational software, foreign language learning has gained increasing attention as the world is becoming a global village and people from different cultural backgrounds have more contacts than ever before. Traditionally, language learning takes place at specific time and location (classrooms) using specific textbook materials. Due to the lack of motive and interactivity, students become dull and uninterested after a short period of time. However, if one is put in a situation in which communication using a foreign language is essential, the motivation becomes immediate. According to the recent report published by Taiwan Tourism Bureau, more and more foreigners visit Taiwan and want to explore Taiwanese culture [2] in the past decade. For foreigners who visit Taiwan, the benefit is quite obvious if there is a mobile application service which can assist users by providing real-time Chinese language information through situational learning and practice. It can help create a ubiquitous learning environment for mobile users. It can also enhance the learning effectiveness and help the users understand the culture in Taiwan in an effortless manner.

The objective of this paper is to develop a mobile application named HuayuNavi to assist Chinese language learning. HuayuNavi is inspired by those who travel, work or study in Chinese-speaking countries and who have a need to understand Chinese when seeing signboards or menus. The purpose is to design an application to make Chinese learning easier for users who have never studied Chinese at all. This is achieved by taking advantage of the versatility of smartphone, including the camera phone, touch screen and wireless Internet connection. By integrating the core technology, namely, off-line Chinese character recognition, the content of a signboard or a restaurant menu can be interpreted automatically. In order to get a comprehensive analysis of language learners' motivation and background information, we conduct a survey before implementing the software. The questionnaire results are utilized to establish the design principles in HuayuNavi.

The rest of this paper is organized as follows. In Section 2, we summarize the related work regarding the relationship between mobile devices and language learning. Section 3 presents the questionnaire statistics before we start the implementation. Section 4 illustrates the proposed mobile application's design concepts, core technologies and user experience. Preliminary test results are also presented and discussed. Section 5 concludes this paper with a brief summary and outlook on future improvements.

2 Related Work

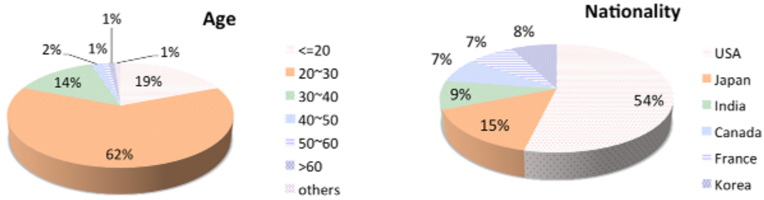
With the rapid growth of mobile phones and services over the past decade, an increasing number of applications are being developed to take advantage of the functionalities of mobile devices, such as multimedia streaming, location-based services, and navigation assistance. As technologies continue to evolve, people can do much more things than ever before. Researchers can put more emphasis on mobile learning as well. [3] studied different methods of education, including distance learning, electronic learning, and mobile learning. They tried to analyze the correlation between exiting mobile devices and the corresponding learning process. They believed that educational process will become more flexible, fulfilling the needs of the life-long learning as well. In addition, it seems that there exists little entrance barrier between new technologies and users right now. Prensky [4] had already observed that students today are all “native speakers” of the digital language of computers, video games and the Internet, so he called them as “Digital Natives”. Since many friendly user interfaces have appeared, people can get familiar with the new technologies without any training in advance.

In contrast to users who are drawn into entertainment or social activities, for language learners, learning context plays an important role. Language knowledge is an interactive production between learner and learning context [5]. [6] pointed out that learner will construct knowledge by perceiving variations of context and reflect corresponding activities or appropriate conversations. In our case, if a mobile application can provide language information for people who are traveling to countries speaking non-native languages, it can assist people in understanding and appreciating the local culture and raise the enjoyment level while on tour. Due to the convenience of mobility and better computing capability, integrated learning materials with mobile devices are accepted and welcomed by mobile users nowadays.

From a technical point of view, we have to interpret the textual information in the photo taken by the user and return the recognition results and related information through the user interface within minimum latency. Off-line intelligent character recognition is the underlying technology to extract textual information from images. There are generally two types of character recognition. One focuses on printed texts, the other focuses on handwriting scripts. The earliest research on Chinese character recognition was reported in [7]. Since printed characters have well-defined structures, the recognition is easier compared to handwriting texts, which usually exhibit structure deformation and shape variations. In this case, preprocessing operations such as de-noising, normalization, or non-linear coordinate transformation are required to guarantee satisfactory performance [8].

3 Market Investigation

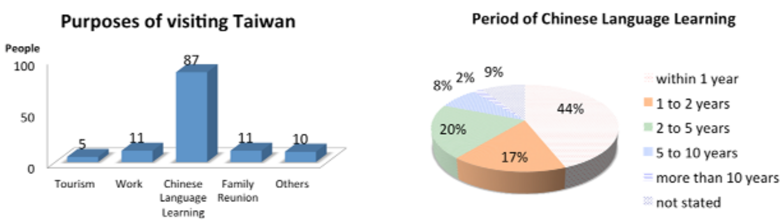
We design a questionnaire about Chinese mobile learning and use the survey results as our development principles. This section will analyze interviewers’ past experiences, background and preferences. The questionnaire was conducted using both online and paper approaches by distributing related information to foreign students who studied at the language learning center of National Taiwan Normal University (NTNU). We released 147 questionnaires, and received 107 valid responses. The detailed analysis regarding the survey follows. According to the results, we can see that the age of the respondents lies mostly between 20 and 30 (62%). 50% of the respondents are American (Fig. 1).



(a) (b)

Fig. 1. The proportion of (a) age and (b) nationality

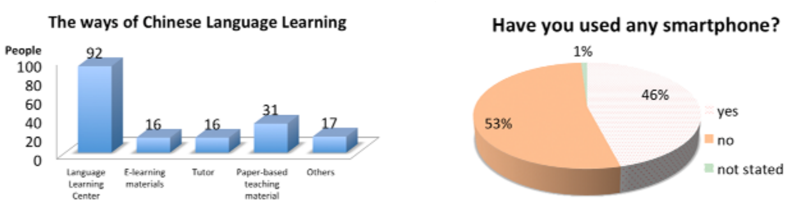
Chinese language learning is the majority proportion in the purpose of visiting Taiwan since most respondents are students from NTNU language learning center. Among those Chinese language learners, over 90% have learned Chinese before (Fig. 2). According to the statistics, we can see that these respondents are mostly Chinese language learners, highly associated with our target users. Hence, after that we can perform further analysis between language learners and mobile devices.



(a) (b)

Fig. 2. (a) Purposes of visiting Taiwan; (b) Length of Chinese language learning

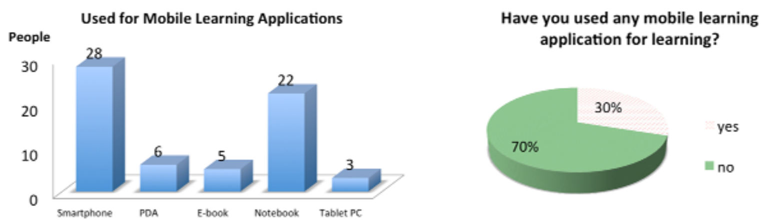
As we mentioned earlier, the majority of participants are from NTNU language learning center (Fig. 3(a)). However, some of them do seek extra assistance by hiring private tutors. About 46% of the people have used smartphone before, a faithful reflection of the current market trend (Fig. 3(b)). With the rapid advances in the mobile technologies, we believe that smartphone will become more prevalent in the near future.



(a) (b)

Fig. 3. (a) The ways of Chinese language learning; (b) Smartphone survey results report

Statistics of past exposure to mobile learning applications suggest that smartphone and notebook are two dominant platforms that people have used for e-learning. However, only 30% of the respondents have actually used smartphones for this specific purpose (Fig. 4). There are many ways to interpret the outcome. We speculate that the main reason is that there exists no well-designed and user-friendly mobile learning application for learning Chinese on the market yet. This motivates us to develop a mobile language learning application to provide effective situational learning experience through sensible integration of modern information technologies.



(a) (b)

Fig. 4. (a) Used for mobile learning applications; (b) Mobile learning application survey reports

4 HuayuNavi App

HuayuNavi is a smartphone based application to assist non-native speakers with learning Chinese in specific subjects. Thanks to the increasing power of smartphone, components that were once thought too complicated and unpractical are now available on modern devices. To build a real-time language learning assistant with so many computation-demanding functions such as user interface, wireless communication and intelligent character recognition, a good system design is needed. We will introduce the design philosophy, core technologies and user experience in the following subsections.

4.1 Design Concept

The objective of this application is to provide a better user experience when learning with smartphones. Thus the user interface becomes a critical part of the system. Due to limited computing resources on mobile devices, we move some complicated processing such as character recognition engine and vocabulary selector to a remote server. The frontend of the system is only responsible for sending the collected information of the request to the backend server and displaying the retrieved data. As illustrated in Fig. 5, HuayuNavi consists of three components: user interface (which belongs to the frontend), recognition engine and vocabulary selector (which are executed on remote servers).

The interface of HuayuNavi allows users to take a picture and select a rectangular area they want perform recognition on. In order to transmit the picture under limited bandwidth, the acquired image will be resized and compressed in advance. The interface also manages listening from the remote server and format the retrieved data to be user-readable. Of course, the user can also report problems caused by the program through the interface. The recognition engine is the core of the system. Once a picture is transmitted to the server, noise removal and segmentation are applied to clean up the image and extract a candidate region. Next, feature vectors will be extracted from the image and passed on to the classification stage. For each candidate character, its corresponding probability will be generated by the recognition engine and fed into the vocabulary selector component to search for the best matching term under domain-specific vocabulary models. Through the cycle, a recognition process is complete and waits for next user request.

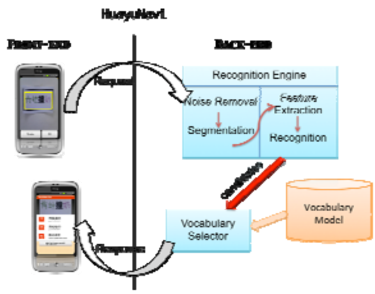


Fig. 5. System flowchart of the HuayuNavi platform

4.2 Core Technologies

Before entering the feature extraction stage, some preprocessing operations are required to remove irrelevant noises so that each selected region will contain exactly one character. Noise removal plays the role of filtering noisy components that may interfere with the subsequent segmentation process. Binarization procedure serves to locate text areas in an input image. Finally, segmentation is performed to separate the previously binarized image into individual character images, as shown in Fig. 6. To achieve efficient segmentation, we adopted simple projection approaches on both horizontal and vertical directions. Just like all character recognition algorithms, the better the segmentation result, the more accurate the recognition will be.

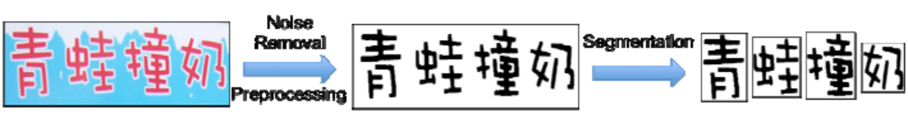
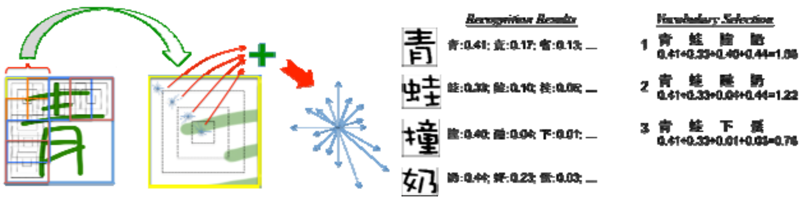


Fig. 6. Noise removal, binarization and segmentation

Since the accuracy of text recognition greatly influences the usability of this system, it is vital to have a high-performance recognition engine. On-line and off-line character recognition problems have been studied quite extensively. The most practical and efficient solution is to compute the distribution of oriented gradients from an image and use support vector machine to classify the feature vector in a high-dimensional hyperspace. In order to balance the efficiency and accuracy, we adopted the framework proposed by [9] and modified it to better suit our problem. The detailed steps of our algorithm are illustrated in Fig. 7(a). First, we divide the input image into 4 by 4 overlapped sub-regions. The percentage of overlapping is set to 50%. Each sub-region is further divided into four concentric rectangles. Then 16 orientations of gradient features are extracted from these four concentric rectangles that are not overlapped with others. Consequently, a vector containing 16-orientation gradient features is created by a weighted combination of the features from each of the concentric rectangle. The 16-orientation feature from each sub-region is concatenated to form a feature vector of 256 dimensions. This can increase the robustness in feature extraction if the input character is deformed or skewed. We adopted support vector machine (SVM) to train and classify the training and testing instances. The problem can be viewed as N-category classification, where N is the number of distinct classes of characters. The benefit of SVM is that the recognition model can be built in advance, i.e., the model can be trained in off-line. The recognition engine can execute efficiently because it is simply a process of finding which hyperspace the feature vector is located. However, SVM usually returns only the best match. In our work, we wish to retrieve top k matches so that domain-specific knowledge can be incorporated with the vocabulary selector component to further improve the accuracy. As reported in [10], it is possible to record the likelihood information between every category when building the SVM model. Therefore, generation of top candidates become feasible and the probability from each candidate can be taken into consideration to increase the confidence of matching in the later stage.

The result from the recognition stage is a list of candidates along with the probabilities for each character image. In the vocabulary selector stage, the goal is to search for the most proper term through different combination of candidates of every character image (Fig. 7(b)). This process can increase the matching confidence if only certain portion of the character images were recognized properly. To address the issue, we adopt a conservative but efficient way to collect Chinese terms belonging to the category to form a domain-specific vocabulary model. In other words, we will have different vocabulary models for different scenarios, e.g., Taiwanese snacks in our preliminary study. When searching for the most proper term, user has to assign the desired domain in advance. Once the recognition engine stage is complete, the list of candidates along with the probabilities for each character image will be used to calculate the score of terms which appear in the vocabulary model. Note that the term must exist in the repository. Here a term's score is defined by adding together the corresponding candidate's probability from each character image. For example, if there is a recognition result with a length of 4 characters as depicted in Fig. 7(b), the proposed vocabulary selector will use the candidates' probabilities to compute the scores for all the terms with the same length within a specific model exhaustively. The one with the highest score is the best answer for this request. In general, only terms with length the same to the number of character images will be considered. Flexible range such as plus/minus one in length is more computation-demanding, but can compensate for the error made in the segmentation stage. It is possible to replace the current scoring mechanism with other approaches. For example, ranking strategy is a strategy that makes use of the ranking (or order) to substitute the candidates' probabilities. Thus, the lower the score is, the more ideal the term is. A hybrid approach, in which only top M candidates for each character image are included in the score accumulation, has also been considered. This can avoid a lot of candidates with very small likelihoods.



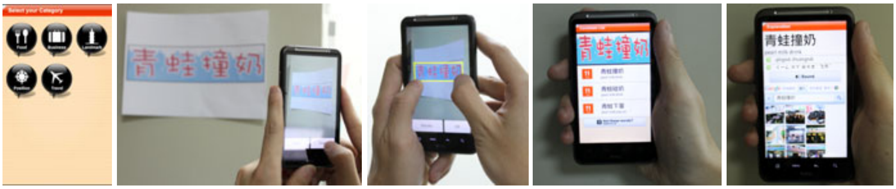
(a) (b)

Fig. 7. (a) feature extraction stage; (b) compute the probability of a vocabulary from recognition results

To evaluate the performance of the proposed system, we have chosen 612 characters which are related to local Taiwanese food to build the character dataset. Each character will generate 60 instances, including 6 fonts, 5 orientations and with/without thinning. Therefore a total of 32760 samples are employed to train the SVM with RBF kernel. We also independently collected 100 character images, in which 60 are generated by computer and 40 are taken from real signboards, to evaluate the recognition performance. From the experiments, the accuracy of top three is 83%, top ten is 89% and top twenty is 92%. If the results can be further incorporated with the vocabulary selector, the final outcome can be improved.

4.3 User Experience

From a user's point of view, designing an intrinsic interface is a crucial part of our system, especially for foreigners. The easier and clearer the interface is the better experience the user has Fig. 8 depicts the system interface (from left to right) of the HuayuNavi application. The main menu (Fig. 8(a)) consists of 9 different subjects, including food, travel, position, art, culture, book, business, entertainment and landmark. Users can choose one subject he or she is interested in, e.g., in the food category. The user then takes the picture of a signboard (pearl milk drink in our example) using the camera phone. A rectangular box will appear and user can resize the box by moving the anchors. The user is advised to crop the desired area as accurate as possible in order to eliminate irrelevant content (Fig. 8(c)). After cropping is finished, the recognition will start by clicking "OK" button. Top three candidates with English translation will be returned by the server and appear on the screen as shown in Fig. 8(d). Furthermore, the detailed explanation, pronunciation and phonetic spelling will be presented if user touches the corresponding buttons. The overall operation can finish within 3 seconds on average. We believe that a short response time is the key factor to keep users stick to this application.



(a) (b) (c) (d) (e)

Fig. 8. The user interface of HuayuNavi

5 Conclusion

People are always looking for language learning platforms which can provide better user experience. In this project, we have successfully built a Chinese learning platform named HuayuNavi on smartphone devices. The system provides an interactive user interface to let the user select the interested area to perform character recognition and browse the recognition results in an organized way. It also provides related materials such as pronunciation and phonetic notation for diverse learning purpose. By using the proposed recognition engine, the recognition accuracy can exceed 83% in top three candidates for a single word. The overall process can be completed in 3 seconds, which is an acceptable duration for most users.

Future work includes better user interface design, finding more general descriptors for text recognition and building a richer vocabulary model. Segmentation is another important issue which greatly affects the accuracy of character recognition. Moreover, we will investigate any potential approach to improve overall accuracy in the semantic level.

References

1. BGR Media, LLC, `http://www.bgr.com/2011/03/10/berg-smartphone-shipments-grew-74-in-2010/`
2. Tourism Bureau, Ministry of Transportation and Communication, Taiwan, `http://admin.taiwan.net.tw/statistics/File/201012/table01_2010.pdf`
3. Georgiev, T., Georgieva, E., Smrikarov, A.: M-learning-a New Stage of -Learning. Citeseer (Year)
4. Prensky, M.: Digital natives, digital immigrants Part 1. On the Horizon 9, 1–6 (2001)
5. Brown, J.S., Collins, A., Duguid, P.: Situated cognition and the culture of learning. Educational Researcher 18, 32 (1989)
6. Clancy, J.: Ecological School Social Work: The Reality and the Vision. Social Work in Education 17, 40–47 (1995)
7. Casey, R., Nagy, G.: Recognition of Printed Chinese Characters. IEEE Transactions on Electronic Computers EC-15, 91–101 (1966)
8. Yamada, H., Yamamoto, K., Saito, T.: A nonlinear normalization method for handprinted Kanji character recognition–line density equalization. Pattern Recognition 23, 1023–1029 (1990)
9. Dong, J., Krzyzak, A., Suen, C.Y.: An improved handwritten Chinese character recognition system using support vector machine. Pattern Recognition Letters 26, 1849–1856 (2005)
10. Lin, H.T., Lin, C.J., Weng, R.C.: A note on Platt's probabilistic outputs for support vector machines. Machine Learning 68, 267–276 (2007)

Webpage-Based and Video Summarization-Based Learning Platform for Online Multimedia Learning

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Abstract. In general, watch and view the whole video is often time-consuming which involves displaying the video film linearly. In this paper, we propose a webpage-based and video summarization-based learning platform (WVSUM). The learning platform provides not only video lecture preview but also combines image, text, and video information as learning materials. The input videos can be automatically transformed into online lectures without human annotators through the subtitle extraction techniques. By means of the extracted caption words, the designed text summarization method is applied to generate the summary. Our summarization approach can generate variant length of video summary by setting up the time constraint. To validate the effectiveness, we compare with the existing fast forwards (one kind of video surrogate interface) and evaluate users' comprehension to video content in the limited viewing time. Thirty undergraduate students were invited to examine the video learning platforms. The experimental results showed that our WVSUM had better effect than fast forwards on comprehension to videos. In terms of system usage and satisfaction, our WVSUM achieved significantly better scores than the classic fast forwards surrogate.

Keywords: video learning, video text summarization, video content-based analysis.

1 Introduction

With the development of multimedia technology, digital video collection is growing rapidly in recent years. Particularly, language learning by video films [6] receives a great attention in the e-learning research fields. How to organize and effectively utilize contents in videos involves many technologies. Examples include text recognition, image processing, etc. Bolle [1] showed that user preferred to search and retrieve videos that indexed previously rather than merely watching tens of thousands movies. While large video resources are available online, a good video summarization technique is important for users to facilitate searching and viewing suitable videos. Therefore, developing such a system to support multimedia learning is indispensable.

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Over the past few years, many video information retrieval and text summarization techniques had been investigated [12]. These methods considerably reduce the ease of searching and browsing video database. However, different content representation styles might produce different effect on learning, in particular, for some learners, who do not prefer displaying film directly and linearly.

Some literatures [11, 7] defined a video surrogate is a condensed video representation that included major features of the original video content. In the other word, the video surrogate style can be thought of a way of video summarization or video abstraction/abstract representation. Good surrogates can help users easily handle and understand the topic inside [4, 13, 7, 5] and also allow them to browse more detail information to obtain incidental learning [2]. Surrogates are specifically essential for friendly user interfaces [7]. Although most video surrogates are text-based, other types such as still image-based (storyboards / keyframe) and motion-based (video skim / fast forward) are emphasized recently. In the past ten years, some researchers had verified the surrogate combined visual and verbal metadata in which each possessed unique contributions of better comprehension and each complemented the other has better effect on users' comprehension and got more preference than only visual or textual surrogate [2]. Another important surrogate component is audio which was considered as an effective factor for capturing key content. This surrogate made use of spoken keywords [7] and audio channel together with the original video to form the learning material. Usually, it is very time-consuming to fuse the above sources since the post-production process is manual-made. For example, it needs to select keywords and re-locate keywords appearing time in videos. Researches argued video fast forwards which allowed great timesaving to watch the full video by speeding up, but with no original audio provided [7]. However, one main limitation of such approach is that the post-production process is needed and is usually time-consuming for human annotators. How to deal with large amount of video collection is also another issue. Furthermore, The FF merely display the whole video according to the preset speed whereas the most informative or important parts is not stress and might be displayed in fast.

In this paper, we present a webpage-based video online learning platform that guide users with the proposed video text summary. This system supports learners to organize information of videos in advance, facilitate searching specific topics or subjects and lead to better comprehension [2]. The designed summarization method is based on keyword-based term weighting scheme. In Chinese text, we first adopt the string analysis to form keywords. Then, the summary is generated by calculating the term weights in each passage. The extracted keywords can not only enhance the effective comprehension in the WVSUM environment, but also give the highlight information [3] of the video transcription. In this paper, two different surrogate representation styles are compared in our video learning platform. They have the respective summarization module: fast forward is simply created by averagely sampling in the post production; WVSUM is created by summarization module operated by techniques of image processing, text summarization, and term weighting scheme. Moreover, WVSUM presents text/graphics separation information and utilizes the keyword spotting as an index generated by keyword weighting scheme. This study aims to examine the effect on user performance and preferences of both video surrogates the video learning platform provides for supporting their comprehension.

2 System Overview

The overall webpage-based video learning platform can be shown in Fig. 1 while Fig. 2 shows the FF system architecture. As shown in Figure 1, there are five key modules in WVSUM, namely, keyword extraction, term weighting, summary generation, image transformation (thumbnail generation), and web-page generation modules. Fig. 3 shows the real implementation of WVSUM.

Given a video, our system firstly split image frames, text (subtitles), and time-stamps into three parts. The frame set can be generated the thumbnails for the thumbnails generation component. The keyword extraction module is to identify keywords in texts. In the term weighting component, we estimate the importance of each word and keywords. The scores of each word can be used to generate the final video summary through the summarization module. In the final stage, the web-page generation modules integrates the produced summary, keywords, thumbnails, and the original video film to form the HTML document. Users can directly watch and show the video film as well as browsing a web-page. Different from the conventional video summarization systems [12], WVSUM provides not only the summary displaying, but also the keyword link to each time stamp in the video.

The FF video learning platform is simply a speed-based video compression technique. Given the time constraint, for example, half size of the video length, the FF will display the input video with 2 times faster than the normal speed. The tighter the time constraint is, the higher displaying speed it plays. However, to make users can watch all the text information, a human annotator is employed to post-process the captions and insert them to the free time stamps in the video. Intuitively, the post-processing is very time-consuming since the human should carefully allocate the keywords.

2.1 Term Weighting Scheme

Different from most western languages, such as English, there is no explicit space symbol between Chinese characters. It is quite difficult to find Chinese words in text. To solve this, we adopt the assessor variety (AV) score [14] to measure the discriminative power of a string. Here the string means a sequence of Chinese characters. When the AV score is above the predefined threshold (we set 4 empirically), the string is treated as a word (term). We extract all words to estimate the weights.

Each keyword is given a weighted score according to the following scheme. These scores will determine the presentation of keywords in the summarization which can be shown in Fig. 3.

The weighting scheme is basically a term frequency-based weighting approach [12, 11] which is commonly used in information retrieval. However, the document frequency here is replaced by the passage frequency. PFi (Equation (3)) means the number of passages which contains term i. aij is the term i in passage j (Pj); tfij is the frequency of term i in passage j. The denominator of the above equation is the normalized factor.

Based on these keywords, the subtitles are detected as video text summary document. There are three to four thumbnails generated from these keyframes as the metadata in the WVSUM. By setting up the time constraint, the final video summaries are produced accompanying with text summaries.

The input video in which subtitle has been embedded is processed in a post-production. The two modules: human annotation and timeline processing are operated. In order to generate same length of video as well as the WVSUM, we speed up the original video by almost ten times.

$$Weight(a_{ij}) = \frac{\log(tf_{ij} + 1.0) \times \log(N / PF_i)}{\sqrt{\sum_j [\log(tf_{ij} + 1.0) \times \log(N / PF_i)]^2}} \tag{1}$$

$$tf_{ij} = freq(term_i \cap passage_j) \tag{2}$$

$$PF_i = \sum O_j \qquad O_j = \begin{cases} 1 & \text{if } P_j \text{ contain } term_i \\ 0 & \text{otherwise} \end{cases} \tag{3}$$

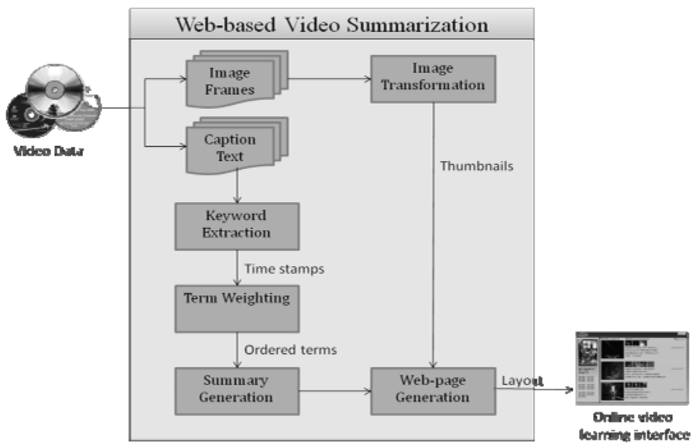

Fig. 1. System architecture of the webpage-based video learning platform

2.2 Video Summary Presentation

Both WVSUM and fast forward approaches need to collect the summary information from previous stage to organise the surrogate. For both methods, we create the video-cover information and a playback interface where users can directly operate. To present the summary, we put all information on the web-page. The WVSUM makes use of the generated summaries by combining the corresponding time information and thumbnails as the HTML document (seeing in Fig. 3). For each paragraph, we sample the thumbnail equally according to the number of detected sentences to form the thumbnail images. The transcription of each paragraph is attached to bottom part of the images. By clicking the image, users can directly watch the video.

On the other hand, the materials for FF is rather simple. It merely adopts the time information and play the whole video under the time limitation control. When user requires to watch the video in a very short time, say, 2~5 minutes, the FF should play the video in a very high speed. Also, labeling keywords for FF is not re-usable to variant time constraints. That is the highlighted keywords only suitable for a fixed-length of summary. If users want to watch the FF summary, the human annotator needs to put the highlighted keywords according to the change of time stamps.

The UI Usage: The following scenarios proposed as example for how two video surrogates support users to learn about video content. People usually get video information from the simple description of the cover page before viewing them, and if they want to obtain more details of videos, they should make a lot effort to watch and annotate them; however, it definitely is time-consuming.

Using either fast forward or WVSUM, users can have a summarization condensed to ten present of the original video content. While users operate fast forward, a semi-automated system, the unique playback window enables users to play directly the video with a high speed rate and a serial visualization presentation, and furthermore, users still can simply understand the video from the original description of the cover page.

Users can browse the most important part of video information from an automated process in WVSUM composed of video cover, the keywords, multiple video summary candidates, the ordered video summary content with summary transcription(with marked keyword), key frames and thumbnails. The video summary candidates is a set of ranked summaries. Usually, the best summary is shown in the first page. In addition, each video summary provides not only three or four thumbnails but its key frame and transcription, and that the thumbnails can be enlarged to view by click on as well as while click on the key frame, the playback window would pop up.

3 Methodology

3.1 Participants and Materials

In this paper, we invite thirty subjects (twenty-four male and thirty-six female) to examine the experiment. All the subjects were undergraduate students between the ages of 18~22 years old. Meanwhile, they all have the experiences of viewing videos online. They were equally sampled from different colleges of the National Central University in Taiwan.

Due to the main purpose to figure out how both surrogates affected users' comprehension to videos, two different domains Discovery videos, which usually are the popular video learning materials were selected to create two surrogate condition, including "The Great Wall" and "The Winner of Animals" which are both 50 minutes-video originally. In this study, the WVSUM set each fragment up for 19 seconds and total summary length is less than 300 seconds which is empirically obtained. For a fair comparison, the fast forwards approach also display the whole video under the same summary length constraint. In other word, it speed-up the video playing 10 times faster than normal speed.

The study administered quizzes to users before and after their viewing the video surrogates with significant video summarization; furthermore, the order of questions and options was not consistent between pre-test and post-test so that the objects had less recollection of the question at post-test time. The quizzes both had ten single choice questions based on the contents of two assigned videos. For example, "Which objects did the ancient people on the Great Wall never use to inform emergency and defend to enemies?"

A satisfaction questionnaire was used to examine how users perceived respectively both video surrogates in the video learning platform. Each question used a five-scales Likert scale and the questionnaire included three main factors: usefulness, ease of use, and satisfaction.

3.4 Procedures

This experiment had two phases. In the phase one, participants should first completed a background survey and took a 10-question single-choice quiz per video to realize prior knowledge in the topic area of videos. In order to counterbalance against memory effects, the treatment phase was executed by a week later after pre-test (phase one). In phase two, we examine the subjects with the arranged session. Participants can view a video by one of surrogates that we prepared during ten minutes. While watching the summaries, participants could pause, jump back and forward or replay. After the ten-minutes viewing, participants were instructed to stop and take a post quiz (not to review video surrogates) followed by filling out usefulness, ease of use, and satisfaction questionnaires in each session. All procedures totally spent 60 minutes and were recorded by a screen recorder.

3.5 Quantitative Analysis

To validate the effectiveness of user performance and preferences, we report the reliability and validity and the questionnaire scores of the FF and our WVSUM.

The reliability average (standardized Cronbach's α coefficient) of the measures of usefulness, ease of use, and the system satisfaction across the studies were 0.906, 0.774, and 0.723 respectively, and the alpha coefficient of 0.905 was for the total scale of reliability. They were all up to the acceptable standard of 0.5 that Kline (1998) had suggested. For the validity analysis, the composite reliability (CR) was 60.93%.

The statistical difference test can be found in Table 1. In this test, the thirty subjects were invited to use both FF and our WVSUM. We then adopt the sampled t-test to evaluate the statistical significant test.

A paired samples *t*-test was performed on the total percentage correct of test to evaluate differences in the performance of learners between using WVSUM and fast forwards (FF). As shown in Table 1, learners scored higher in using WVSUM (Mean = 3.80, std = 2.23) than FF (Mean = 1.40, std = 1.83). There was a statistical significant difference between the two video surrogates with regard to the performance of learners under $p < 0.001$. Although the standard deviation of the FF was smaller than WVSUM, all scores of test by using FF were generally lower than WVSUM.

We use the five-scale Likert scale to evaluate the three rates: ease of use, usefulness, and satisfaction. After the overall experiments, learners were required to fill the questionnaire. Then, the paired sample *t*-test was performed to compare our method and FF. Table 2 shows the empirical result. From this Table, it is clear that WVSUM reaches better mean value than FF. In terms of the result of test, WVSUM has statistical significant difference (p<0.001) from FF.

Table 1. Empirical result of the score of test

	Number of subjects	***Mean***	***std***	***p***
WVSUM	30	3.80	2.23	.000
Fast Forwards	30	1.40	1.83	-

Table 2. The result of the satisfaction questionnaire

		Mean	*std.*	*p*
Ease of Use	WVSUM	4.048	.701	.000
	Fast Forwards	1.967	.546	-
Usefulness	WVSUM	3.833	.900	.000
	Fast Forwards	2.456	.984	-
Satisfaction	WVSUM	3.778	.621	.000
	Fast Forwards	1.867	.558	-

Fig. 2. System demonstration of the webpage-based video summarization (WVSUM)

4 Conclusion

This paper presents a webpage-based video learning platform which integrates image processing, text summarization and keyword extraction techniques to produce learning materials. Our method can generate variant length of video summary and keywords automatically. To validate this idea, sixty undergraduate students were invited to examine the lecture comprehension intensity. The empirical results showed that our WVSUM yields statistically significant better learning effects on ease of use, usefulness, and satisfaction. By observing from the learning activity, most learners need to pay much more attention to FF learning platform. On the contrary, the WVSUM provides not only visual but also verbal information as content. Learners often watch the image and text of the produced summary and then playing the video summary. Most participants agree that WVSUM provides more media sources for better comprehension.

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References

1. Bolle, R. M., Yeo, B. L., Yeung, M. M.: Content-based digital video retrieval. In: International Broadcasting Convention, pp. 160–165 (1997)
2. Ding, D., Marchionini, G., Soergel, D.: Multimodal surrogates for video browsing. In: Fourth ACM Conference on Digital Libraries, pp. 85–93 (1999)
3. Koutrika, G., Zadeh, Z.M., Garcia-Molina, H.: Data clouds: summarizing keyword search results over structured data. In: 12th International Conference on Extending Database Technology: Advances in Database Technology, pp. 391–402 (2009)
4. Lienhart, R., Pfeiffer, S., Effelsberg, W.: VisualGREP: a systematic method to compare and retrieve video sequences. Journal of Multimedia Tools and Applications 10(1), 47–72 (2000)
5. Marchionini, G., Song, Y., Farrell, R.: Multimedia surrogates for video gisting: Toward combining spoken words and imagery. Information Processing and Management 45(6), 615–630 (2009)
6. Mayer, R.E.: Multimedia learning, 2nd edn., pp. 1–15. Cambridge University Press, New York (2009)
7. Song, Y., Marchionini, G.: Effects of audio and visual surrogates for making sense of digital video. In: SIGCHI Conference on Human Factors in Computing Systems, pp. 867–876 (2007)
8. Wildemuth, M., Marchionini, G., Wilkens, T., Yang, T., Geisler, G., Fowler, B., Hughes, A., Mu, X.: Alternative surrogates for video objects in a digital library: users' perspectives on their relative usability. In: 6th European Conference on Research and Advanced Technology for Digital Libraries, pp. 16–18 (2002)
9. Wildemuth, M., Marchionini, G., Yang, M., Geisler, G., Wilkens, T., Hughes, A., Gruss, R.: How fast is too fast?: evaluating fast forward surrogates for digital video. In: 3rd ACM/IEEE-CS Joint Conference on Digital Libraries, pp. 221–230 (2003)
10. Yang, M., Wildemuth, B.M., Marchionini, G., Wilkens, T., Geisler, G., Hughes, A., Webster, C.: Measuring user performance during interactions with digital video collections. American Society for Information Science and Technology 40(1), 3–12 (2003)
11. Yang, H., Chaison, L., Zhao, Y., Neo, S.Y., Chua, T.S.: VideoQA: question answering on news video. In: 11th ACM International Conference on Multimedia, pp. 632–641 (2003)
12. Yang, J.C., Huang, Y.T., Tsai, C.C., Chung, C.I., Wu, Y.C.: An automatic multimedia content summarization system for video recommendation. Educational Technology & Society 12(1), 49–61 (2009)
13. Yeo, B.L., Yeung, M.M.: Retrieving and visualizing video. Communications of the ACM 40(12), 43–52 (1997)
14. Zhao, H., Kit, C.: Incorporating global information into supervised learning for Chinese word segmentation. In: 10th Conference of the Pacific Association for Computational Linguistics, pp. 66–74 (2007)

Effects of Learning English Maxim through M-Learning with Different Content Representation

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Abstract. English maxim is the important elements when it refers to foreign language performance. Learning tools assisted by mobile technology (M-Learning) has been proved to be a great one to learners for self-learning anytime and anywhere. The participants of the study were selected from one large university in the middle of Taiwan. The researchers chose participants from Department of Foreign Language (DFL) and Department of Non-Foreign Language (DNFL). One hundred and twenty-one students were from DFL, and 137 students were from DNFL. In accordance with learner's short-term memory (STM) ability, the researchers divided learners into four quadrants. Quadrants 1(Q1) consists of learners with higher STM ability in verbal and higher STM ability in visual. Quadrants 2(Q2) comprises learners with lower STM ability in verbal and higher STM ability in visual. Quadrants 3(Q3) includes learners with lower STM ability in verbal and lower STM ability in visual. Quadrants 4(Q4) is composed of learners with higher STM ability in verbal and lower STM ability in visual. Besides, Learning Content Representation (LCR) Types are clarified into three types (Type A, B, C) according to two main learning modes (verbal mode and visual mode). The research question is that for learners with different learning preferences (Q1, Q2, Q3, Q4), how Learning Content Representation Types (LCR type A, B, C) affect the learning outcome of English maxims? Our findings showed providing learning content with pictorial annotation (Type A) could aid learners with lower verbal ability and higher visual ability (Q2) to have better outcomes because these learners find it easier to learn content presented in a visual form rather than in a verbal form. Providing learning content with both written and pictorial annotation (Type C) can assist learners with higher verbal ability and higher visual ability (Q1) in the recognition test. According to the Cognitive Load theory, providing too much information might cause a higher cognitive load and lead to irritation and lack of concentration. It implied that providing basic learning materials (only written annotation, Type B) is notably helpful to learners with lower verbal ability and lower visual ability (Q3). The research results could provide instructors or learners as learning strategies to promote their English ability.

Keyword: M-Learning, Learning Content Representation, English Maxim.

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1 Introduction

English maxim knowledge is the important elements when it refers to foreign language performance. The more learners read and appreciate maxims, the more knowledge about culture, literature and language they may acquire in their English language learning [39]. Previous researchers define English maxims as "a succinct and memorable statement that contains advice, a warning or a prediction, or an analytical observation" [16]. Based on these characteristics, maxims are widely used in daily life as the followings. First, maxims are alive in daily conversations. Second, maxims can also be used in a writing classroom. Third, maxims are valuable tools for teachers to show students the beauty of language. Fourth, maxims are thought as cultural products that reveal cross-cultural beliefs and behaviors [41]. Though it is crucial that word learning is essential to English learning, some factors such as lacking word *learning tools* and *memorizing strategies* make acquiring English maxims a tough task. Therefore, it is urgent for English as Foreign Language (EFL) learners to find effective learning tools, strategies for enhancing interaction in classroom to assist maxim learning.

Learning tools assisted by mobile technology (M-learning) has been proved to be a great one to learners for self-learning anytime and anywhere. An abundance of evidence from research suggested that mobile devices such as laptops, personal digital assistants (PDAs), and mobile phones have been applied as learning tools to support language learning and teaching [42]. Among the mobile devices, mobile phones are most commonly used [28]. Short message service (SMS) is one of the major capacities of mobile phones, and research has been done on using SMS through mobile phones to assist learning to date [23]. Reasons to the high frequency sending of SMS include low price and asynchronous nature.

Another factor that impedes learners in word learning is that learners have problems in lacking *strategies for memorizing* words [43]. Human beings not only use a single way to memorize information. Dual Coding Theory (DCT) that both verbal and visual systems were regarded as independent systems which deal with different types of information. The verbal system mainly deals with auditory, visual words, and writing words [33]. The major function of visual system is to deal with scenes and mental images. Thus, learning materials can be supported in a specific manner by presenting with two Learning Content Representation Types (LCR): visual and verbal [29].

2 Literature Review

Current developments in information technologies have resulted in rapid advances in the application of instructional and educational technology. Learners in such environment are usually allowed to decide for themselves the type of information they prefer to access and the order in which they process different types or modes of information (e.g. in a verbal or a visual mode)[25].Thus, psychological theories on individual differences in learning preferences come into play. As researcher who called for more researches on the role of individual differences are concerned with the question of whether verbalizers and visualizers differ in their behavior in the learning environment and how the differing needs of verbalizers and visualizers can be supported to improve their overall learning outcomes [35].

As a result, addressing conditions of English language teaching in its social context, defining different styles of learning (e.g. verbal and visual), determining individual differences in language learning, and identifying the interaction of these variables are the focus of this section of our literature review.

2.1 English Language Teaching in Its Social Context

Compared with contemporary teaching methods, the old standby technique for dialog-plus-picture is a natural habitat in which the teacher is Controlling Parent and learner is Adopted Child can coexist and reinforce each other [27]. If the teachers can provide frequent and rich opportunities for the Adult and Natural Child to take over, and both of them turned out students willing and able to use their new language [33]. Words that are coded dually in two modes (verbally and nonverbally, i.e., with pictures) would be learned well than those coded only verbally [30]. For instance, in a study involving the use of video and subtitling, found that a combination of video input and bimodal verbal input which include written words (e.g. subtitles in the foreign language) and audio (e.g. audio in the learner's native language) in the contexts aided vocabulary leaning [2] . In other words, students learn new words when they can establish a direct connection between a word in their native language, the corresponding picture of an object or action, and its foreign equivalent.

2.2 Verbalizers and Visualizers Learning Preferences

Since the 1950s, our culture has moved from Mechanical into Informational Age, from a "hearing" culture into a highly networked, interactive "seeing" culture [32]. Due to the change of environment, the teaching methods are indeed influenced step by step. Moreover, with the improvement and rapid advancement of technology, the mode of teaching goes diversely, especially for the second-language (L2) learning [4]. In study of L2 learning, L2 reading skills are highly correlated with Short-Term Memory (STM) ability [34]. The research found significant correlation between STM ability and L2 writing proficiency as measured by the test of written language [17].

A new concept of STM which is called the Working Memory Model (WMM) states outer information to actually process in three different parts when it enters into STM via sensory memory [5]. The term "working memory" (WM) became popular during the 1980s and 1990s. It refers to a temporary processing and storage of information [5]. WMM as a system composed of one Central Executive (CE) with three subsystems, including Phonological Loop (PL), Visuo-spatial Sketch Pad (VSSP) and Episodic Butter (Figure 1), where outer information is not only temporarily stored but is also processed at the same time. The darker areas represent long-term (LT) or crystallized knowledge and the lighter areas represent working memory. That is, the Multi-Stored Model (MSM) viewed STM only as storage, whereas the WMM not only viewed STM as storage but also as a system with different kinds of processing powers. Therefore, STM ability in this paper refers to the PL STM ability and VSSP STM ability. In general, PL STM ability refers to verbal ability and VSSP STM ability refers to visual ability [31].

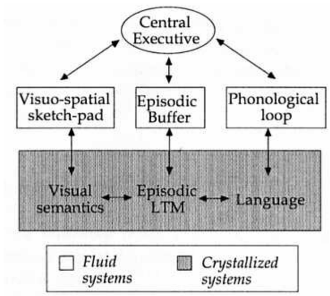

Fig. 1. Working Memory Model [9]

Research shows that learning can be supported by presenting visual and verbal learning materials in a specific manner [1]. Besides, they state that one of the most important functions of instructional materials is to help students construct referential connections between two forms of mental representation: the verbal representational system and the visual representational system. Among the instructional materials, the use of annotation is one of the instructional strategies. There are two major types of annotations: written and pictorial [2]. The written annotation is for verbal, while pictorial annotation is for visual. In this study the researchers will use written annotation and pictorial annotation as the instructional strategies.

2.3 Individual Differences in Language Learning Ability

Except for offering learners appropriate LCR types, the individual differences in language learning is also worthy of discussing. Perceptual styles are a matter of students' choice, but that preference develops from infancy in a subconscious way [9]. Recently, it matters fundamentally which instrument is chosen, especially when considering the learning styles for relatively mature learners [36]. The results of observing individual differences of children with high, medium, and low achievement in learning through information and communication technologies, moreover research found interesting and unexpected individual differences based on gender and learning achievement [3]. Furthermore, they indicated that the necessity of investigating the use of learning style, personality type or approach to examine their roles in using information and communication technologies for learning [13].

The learning strategy literature assumes that successful learners are different in using particular extent in cognitive processes and behaviors to enable themselves to be successful [19]. For examples, even if learners are in the same learning environment, learn the same target language, speak the same native language, and in the same language level, there will be difference between them because of their different learning types [22]. Some will be more analytic, while some will be intuitive, and some prefer to hear the language [6]. Moreover, it is also assumed that depend on each learner's learning type, there are various ways to be successful, but some learning types don't work in the learning task of any learners [8].

2.4 Relationships between LCR Types and Individual Differences

From researchers' point of view, there is no denying that individuals have their own preferred learning modes. Consequently, the way learners interact with their environment and how they acquire and process verbal versus visual information should be paid more attention [26]. The researchers have to make sure that the proper learning methods learners choose, the better learning outcomes they have [21]. However, integrating with distinct learning modes is another topic to be discussed for our study. According to the generative theories of comprehension, learners have to build referential connections in working memory between the mental representations of ideas or propositions that have been presented in different modes [18].

Further to the discussion, the Dual-Coding Theory (DCT) says that learning is more effective when learners use more than one sensory modality, for instance, verbal and visual processing together, and when connections are clearly made between the information contained in each modality. The researchers therefore hypothesize that giving multi-sensory learning content by combining written and pictorial annotation will affect learning performance differently for students with different verbal and visual abilities [15]. Moreover, from the Cognitive Load Theory perspective [38], information may only be stored in LTM after first being attended to and processed by STM. However, STM is extremely limited in both capacity and duration [44]. Under some conditions, these limitations will impede learning.

In conclusion, how to make learning become more efficient is a very important issue in our dissertation. Many people will confront the similar problem in the learning process, which are how to memorize the target content and how to make links systematically between them. Hence, if educators can think outside of the box and forward to provide a more multi-learning style environment in order to correspond with the demands of individual learner, therefore, it will make learners have more opportunities to choose their suitable learning style. Thus, it would bring about a more striking learning effect in their learning process.

3 Methodology

3.1 Participants

The participants of the study were students selected from one large university in the middle part of Taiwan. The researchers chose students from Department of Foreign Language (DFL) and Department of Non-Foreign Language (DNFL). One hundred and twenty-one students were from DFL, and 137 students were from DNFL.

Besides, the students were between 18 and 30 years of age and were all enrolled for credit. However, in order to have more statistical significance, the researchers used 258 as the sample size. Ten subjects did not provide the necessary information, so their data were removed from the study, leaving a total of 248 students.

Since each learner has a different STM ability for processing the content of different LCR types, different LCR types would need to fit with each learner's individual STM ability to achieve a better learning performance. The researchers therefore classified learners into four groups according to their English abilities and STM abilities (see Fig 2).

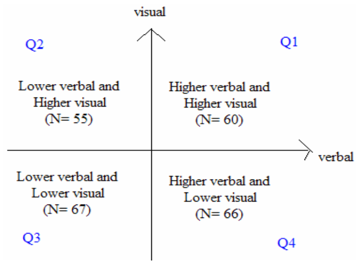

Fig. 2. The four groups in this experiment

3.2 Instruments

3.2.1 STM Ability Test

The system design is based on a flash game provided by YouthWant Website, with some modifications to fit for the study. According to "Index of Learning Styles Questionnaire" which was designed by Soloman and Felder (1988), there are 11 questions with reference to verbal and visual categories in total [37]. Therefore, the researchers took 12 questions in the STM ability test, six questions for written materials and six for pictorial materials. Each question was presented by Microsoft Office PowerPoint for nine seconds and the participants will be given seven seconds to answer. The system architecture of STM ability test and examples of written and pictorial content can be found in *Appendix A*.

3.2.2 Original English Proverb Ability Test

Before conducting the experiment, the researchers had to assess the students' original English proverb abilities to avoid those English proverbs that students were already familiar with. The researchers chose 50 proverbs for testing students' original English proverb ability. The corpuses used in the experiment are sampled from "PROVERBS : Over 750 English Proverbs from basic, medium to advanced level" suggested by the website of Syvum Technological Incorporated (1999).The number represents its level, for example, the entry < ① All that glitters is not gold. >, < ② Forbidden fruit is sweet. >, and < ③ Let not your wits go wool-gathering. > represent that number one means basic level, number two means medium level and number three means advanced level respectively. To obtain 50 proverbs for testing students' original English proverb ability, the researchers selected 16 proverbs from basic level, 17 proverbs from medium level and 17 proverbs from advanced level. *Appendix B* contains the list of these 50 English proverbs. While sitting for this test, students were asked to write down the Chinese meaning of each English proverb. Their answers were counted as correct as long as the students gave one answer for a proverb with similar meanings. After students completed this original English proverb ability test, the researchers found that most students could only get the correct answers up to the certain level, which implies that the students' original English proverb ability is at about this level.

3.2.3 Memorization of English Proverbs

The researchers selected the 24 English proverbs for the experiment after the certain level, as these English proverbs were all new to the students. *Appendix C* shows the list of the 24 selected proverbs. Each of these 24 proverbs was then represented in three different ways and each LCR type had eight proverbs for the experiment:

LCR type A – providing the English proverb information, plus pictorial annotation such as a picture to represent the meaning of the English proverb;
LCR type B – providing the English proverb and its Chinese translation, this is basic learning material (only written annotation); and
LCR type C – providing the English proverb information, similar to LCR type A, plus pictorial annotation and written annotation. Examples of the three different LCR types for one English proverb are shown in *Figure 3*.

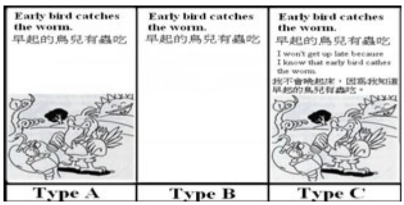

Fig. 3. An example of the three types of Learning Content Representation for the English proverb "Early bird catches the worm"

3.2.4 English Proverb Recognition and Recall Test

With a view to assessing the students' English proverb learning performance, the researchers had the English Proverb Recognition and Recall (EPRR) test that the researchers randomly selected four proverbs from each LCR type to be the question of the EPRR test. *Appendix D* shows the question in the EPRR test, and there were six questions for the recognition test and six questions for the recall test, in this way, the total of questions in this EPRR test was 12. The question 1(q1) and question 2(q2) in the recognition test and the question 1(q1) and question 2(q2) in the recall test were presented by LCR type A; the q3 and q4 in the recognition test and the q3 and q4 in the recall test were presented by LCR type B; the q5 and q6 in the recognition test and the q5 and q6 in the recall test were presented by LCR type C. However, test and measurement studies indicate that these two forms of testing are quite different and demand separate processing strategies. For example, recognition tests usually involve multiple-choice activities in which learners select or guess the correct response from the given alternatives. Such tests may strengthen any existing memory traces. On the other hand, recall tests demand the production of responses from memory. It is more difficult than recognition because learners must search for the correct response within their mental representation of the newly experienced information (Chen, Hsieh, & Kinshuk, 2008). Figure 4 and Figure 5 show examples of a recognition test item and a recall test item, respectively, in our study.

Fig. 4. Example of a recognition test item

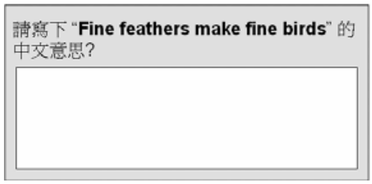

Fig. 5. Example of a recall test item

3.3 Procedure

The experimental procedure consisted of five steps, as presented in Figure 4. In the first step, participants met with the researchers in a classroom, and each participant was asked to fill out background information (ex. class, number, age, gender, and so on). Then participants were told that the purpose of this experiment was to learn English proverbs and they would go through an experimental procedure with five steps as shown in Figure 6. This first step would take about three to five minutes.

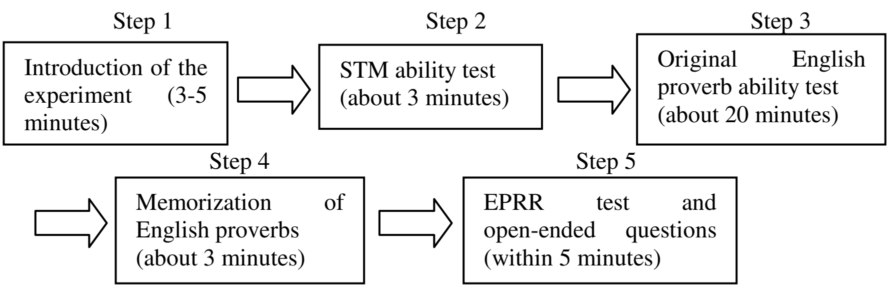

Fig. 6. Experimental procedures

4 Results

The EPRR test score was used for assessing the learning outcome in our study. Table 2 shows the descriptive statistic results. For English learners with higher verbal ability and higher visual ability (Q1), would achieve better results *in the recognition test* from learning content with both pictorial annotation and written annotation (Type C) than they would from learning content with only pictorial annotation (Type A) or only written annotation (Type B). That is to say the use of more than one modality by learners (learners presented with combined-annotation type C content) is more effective than the use of single modality (learners presented with only single-annotation type A and type B content). However, results also suggest that providing basic learning materials (only written annotation, Type B) could help learners with lower verbal ability and lower visual ability (Q3) to have better outcomes *in the average score of EPRR test* than learning content with only pictorial annotation (Type A) or both pictorial annotation and written annotation (Type C). In another word, for the group with lower verbal ability and lower visual ability (Q3), learners presented with combined-annotation content (Type C) did not perform significantly better.

Table 1. Descriptive statistics

			Proverb		Recognition Score		Recall Score		Average Score	
		N	Score	Type	*M*	*SD*	*M*	*SD*	*M*	*SD*
Q 1	Higher Verbal Higher Visual	60	12.04	A	8.60	3.88	7.30	4.95	7.95	3.49
				B	10.30	3.33	8.50	4.59	9.40	3.24
				C	11.50	1.67	5.20	5.00	8.35	2.82
Q 2	Lower Verbal Higher Visual	55	11.87	A	9.82	2.91	8.51	4.11	9.16	2.67
				B	10.80	2.68	9.05	4.30	9.93	2.64
				C	12.00	0.00	5.67	4.96	8.83	2.48
Q 3	Lower Verbal Lower Visual	67	11.44	A	9.40	3.17	7.34	4.65	8.26	3.06
				B	10.57	2.58	8.60	3.94	9.58	2.52
				C	11.37	1.84	6.00	4.67	8.22	2.39
Q 4	Higher Verbal Lower Visual	66	13.02	A	8.49	3.34	8.03	4.15	8.42	3.12
				B	11.54	1.75	8.03	4.53	9.74	2.60
				C	11.61	11.59	4.89	4.23	8.51	2.56
	Total	248	12.09							

Quantitative results imply that learners with lower verbal ability and higher visual ability (Q2) would benefit more from learning content with pictorial annotation (Type A) than any other quadrants (Q1, Q2, Q3). This condition was valid both *in the recognition test* and *in the recall test* in this experiment. From the quantitative findings, the more suitable method to assist these learners (Q2) in studying English proverbs is to provide them with more pictorial annotation and less written annotation. On the other hand, for English learners with higher verbal ability and lower visual ability (Q4), would result in significantly higher scores *in the average score of EPRR test* from learning content with written annotation (Type B) than any other learning content representation types (LCR type A and C). Nevertheless, this condition was not vivid both *in the recognition test* and *in the recall test*. Consequently, we should be cautious about claiming that "providing this type of learner with more written annotation is a suitable teaching strategy in learning English proverbs.

5 Discussion

This study addressed the issue of content adaptation in English proverb learning. To identify a promising solution, two dimensions have been taken into consideration: instructional strategies (LCR type: written annotations and pictorial annotations) and learner's cognitive model (STM ability: verbal and visual). The findings should contribute to the design of more effective content adaptation solutions for English proverb learning.

Previous studies of the effects of visual association on memory found that, in the acquisition of vocabulary, foreign words associated with actual objects or imagery techniques are learned more easily [35]. Therefore, providing learning content with pictorial annotation (Type A) in the English proverb learning can help learners with lower verbal ability and higher visual ability (Q2) learn better, since they have better skills for learning content presented in visual form as opposed to being presented in verbal form.

It should be noted that, theoretically, learners with higher verbal ability and lower visual ability (Q4) should exhibit better skills for learning verbal materials. Therefore, providing them with learning content in verbal form (Type B) should achieve better results than providing content in a nonverbal form. However, this condition only valid *in the average scores of EPRR test* but not in the recognition test and in the recall test in the experiment. It showed that further study is needed to analyze if providing this type of learner (Q4) with more written annotation is indeed an appropriate teaching strategy in English proverb learning.

The study also supported the effect of Dual-Code Theory (DCT) which says learning is more effective when learners use more than one sensory modality. Researchers hypothesized that giving multi-sensory learning content by combining written and pictorial annotation will affect learning performance differently for students with different verbal and visual abilities [11], such as in the case of learners with higher verbal ability and higher visual ability (Q1). The quantitative results proved that Q1 learners would have better outcomes *in the recognition test* from learning content with written annotation and pictorial annotation (Type C) than they would from learning content with only pictorial annotation (Type A) or only written annotation (Type B).

The effectiveness of particular strategies is influenced by variables, such as proficiency level, background knowledge, context of learning, target language and learner characteristics [7]. In the light of this theory, the researchers found that there were some relationships between the learning context and the learning outcome. From the point of view, the researchers presumed, in short-term memory, that it would cause the cognitive load if the learning context was too complicated. Based on the Cognitive Load Theory, providing too many written or pictorial annotations (Type C) for lower verbal ability and lower visual ability learners (Q3) would cause frustration and increase negativity to Q3 learners [11].

As for future study, in order to provide a wider perspective, it would be more promising to contain more questions in the STM ability test, so as to make the outcomes more precise. Further study is also recommended on the same framework with multimedia such as computer, smart phones or PDA instead of traditional paper work, in order to enhance the effectiveness of learning.

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References

1. Abu-Rabia, S.: The influence of working memory on reading and creative writing processes in a second language. Educational Psychology 23(2), 209–222 (2003)
2. Al-Seghayer, K.: The effect of multimedia annotation modes on L2 vocabulary acquisition: a comparative study. Journal of Language Learning & Technology 5(1), 202–232 (2001)
3. Ardila, A.: Language representation and working memory with bilinguals. Journal of Communication Disorders 36(3), 233–240 (2003)
4. Atkinson, R.C., Shiffrin, R.M.: Human memory: A proposed system and its control processes. In: Spence, K.W., Spence, J.T. (eds.) The Psychology of Learning and Motivation. Academic Press, London (1968)
5. Baddeley, A.: Working memory and language: an overview. Journal of Communication Disorders 36(3), 189–206 (2003)
6. Bauer, L., Nation, P.: Word families. International Journal of Lexicography 6(4), 253–279 (1993)
7. Benson, P.: Learning development and language learning. In: Teaching and Researching Autonomy in Language Learning, pp. 144–147. LSP, Malaysia (2001)
8. Bowen, B.M.: Look Here! Visual in language teaching. Macmillan, London (1982)
9. Cermak, L., Craik, F.: Levels of Processing in Human Memory. Erlbaum, Hillsdale (1979)
10. Chen, C. L. : An action research on using creative thinking teaching in instruction of transforming verbal elements into visual images. Graduate Institute of Visual Art Education, National Dong Hwa University. From Electronic Theses and Dissertation System (October 13, 2008), `http://etds.ncl.edu.tw/theabs/service/detail_result.jsp`
11. Chen, N.S., Hsieh, S.W., Kinshuk: Effects of short-term memory and content representation type on mobile language learning. Language Learning & Technology 12(3), 93–113 (2008)
12. Chiang, M.Y., Liao, B.S.: Patterns of English language learning students with learning strategies. Electronic Journal of English Education 35, 6–8 (2007)
13. Christopher, N.C., Mercer, N.: English Language Teaching in its Social Context. Macquarie University & The Open University, London (2001)
14. Cohen, A.D., Aphek, E.: Basifying second language learning. Studies in Second Language Acquisition 3(2), 221–236 (1981)
15. Courtney, M.S.: An area specialized for spatial working memory in human frontal cortex. Science 279(5355), 1347–1351 (1998)
16. Crystal, D.: The Cambridge encyclopedia of language. Cambridge University Press, Cambridge (1997)
17. Earl, W.S.: Meaning & Method: A view of language teaching, 2nd edn. International Thomson Publishing Company, USA (1996)
18. Fuster, J.M.: The Prefrontal Cortex: Anatomy. In: Physiology and Neuropsychology of the Frontal Lobe. Neurosci: Res. (1994)

19. Geva, E., Ryan, E.B.: Linguistic and cognitive correlates of academic skills in first and second languages. Language Learning 43, 5–42 (1993)
20. Glover, J.A.: The testing phenomenonNot gone but nearly forgotten. Journal of Educational Psychology 81(3), 392–399 (1989)
21. Hair, J.F., Tatham, R.L., Anderson, R.E., Black, W.C.: Multivariate Data Analysis, 5th edn. Prentice-Hall, Inc., New Jersey (1998)
22. Harrington, M., Sawyer, M.: L2 working memory capacity and L2 reading skill. Studies in Second Language Acquisition 14(1), 25–38 (1992)
23. Hsieh, S.W.: Study on adaptive learning based on Short-term memory capacity in mobile learning environment. Doctoral Dissertation, National Sun Yat-Sen University (2006)
24. Hyerle, D.: Visual tools for constructing knowledge. Association for Supervision and Curriculum Development, USA (1996)
25. Jonassen, D., Tessmer, M.: An outcome-based taxonomy for instructional systems design, evaluation and research. Training Research Journal 2, 11–46 (1996)
26. Jones, L.: Testing L2 vocabulary recognition and recall using pictorial and written test items. Journal of Language Learning & Technology 8(3), 122–143 (2004)
27. Liao, B.S.: English as a global language and its effects on Taiwan's English education. English Teaching & Learning 29(1), 107–121 (2004)
28. Liu, P.L., Chen, C.J., Chuang, K.C., Chen, P.Y.: Effects of computer-based individual concept map and computer-based collaborative concept map on writing performances for learners of different writing. In: Proceedings of the Asia-Pacific Conference on Technology Enhanced Learning, article 118 (2010)
29. MacGregor, J.N.: Short-term memory capacity: limitation or optimization? Psychological Review 94(1), 107–108 (1987)
30. Mayer, R.E., Sims, K.: For whom is a picture worth a thousand words? Extensions of a dual-coding theory of multimedia learning. Journal of Educational Psychology 86(3), 389–401 (1994)
31. McDaniel, M.A., Mason, M.E.J.: Altering memory representations through retrieval. Journal of Experimental Psychology. Learning, Memory and Cognition 11, 371–385 (1985)
32. Miller, G.A.: The magical number seven plus or minus two: Some limits on our capacity for processing information. Psychological Review 63, 81–97 (1956)
33. Nation, I.S.P.: Learning Vocabulary in another Language. Cambridge University Press, Cambridge (2001)
34. Olson, I.R., Jiang, Y.: Visual short-term memory is not improved by training. Memory & Cognition 32(8), 1326–1332 (2004)
35. Plass, J.L., Chun, D.M., Mayer, R.E., Leutner, D.: Supporting visual and verbal learning preferences in a second-language multimedia learning environment. Journal of Educational Psychology 90(1), 25–36 (1998)
36. Pressley, M., Levin, J.R., Miller, G.E.: The keyword method compared to alternative vocabulary learning strategies. Contemporary Educational Psychology 7, 50–60 (1982)
37. Soloman, B.A., Felder, R.M.: Index of Learning Styles Questionnaire (1988), `http://www.engr.ncsu.edu/learningstyles/ilsweb.html`
38. Sweller, J.: Cognitive load theory, learning difficulty and instructional design. Learning and Instruction 4, 295–312 (1994)
39. Syvum Technologies Incorporated: PROVERBS Over 750 English Proverbs for Kids, Teens & College Students (1999), `http://www.syvum.com/proverbs/`

40. Taylor, I., Taylor, M.: Psycholinguistics: Learning and Using Language. Prentice Hall, New Jersey (1990)
41. Tsai, J.J.: Using proverbs to teach English as a second/foreign language. Graduate Institute of Foreign Literature, Tamkang University. From Electronic Theses and Dissertation System (2008), `http://etds.ncl.edu.tw/theabs/site/sh/detail_result.jsp`
42. Tseng, C.R., Chu, H.C., Hwang, G.J., Tsai, C.C.: Development of an adaptive learning system with two sources of personalization information. Computers & Education 51, 776–789 (2008)
43. Wenden, A., Rubin, J.: Learner strategies in language learning. Prentice-Hall International, UK (1987)
44. Wright, B.D.: Rasch model from Campbell concatenation. Rasch Measurement Transactions 2(1), 16 (1988)

Mobile Terminal-Based Tennis Instruction Support System for Beginners

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Abstract. Visualization technologies are becoming more widely used in sports sciences. In addition to video analyses, many kinematic analyses of sports participants conducted using various sensors have been reported. The present paper proposes a method for evaluating the serve and stroke forms of tennis players by measuring ground reaction force and video analysis. In the study, we (1) perform simultaneous outdoor measurement of racket movements and ground reaction forces, (2) measure visual data feedback to an individual trainee by means of a mobile terminal from a Web server, and (3) perform a system feasibility study with the assistance of a university tennis class to evaluate the performance of the proposed system. A preliminary experiment conducted during a university tennis class has revealed the system feasibility.

Keywords: tennis serve, stroke, ground reaction force, video, mobile terminal.

1 Introduction

Increasingly, learning and training utilize computers because of improvements in signal processing and multimedia capabilities. Therefore, visualization technologies are becoming more widely used in sports sciences [1]-[6]. In addition to video analyses, several studies have reported kinematic analyses of sports participants using various sensors (e.g., [3], [4]). Nosu et al. investigated the characteristic ground reaction forces involved in baseball batting [3]. They used force plates and a motion capturing system using two video cameras for analysis.

The present paper proposes a mobile terminal-based tennis instruction support system for beginners. This system provides serve and stroke form information obtained through measurement and analysis of ground reaction forces and motion capture. In addition to the data of the model player, data for an individual trainee is distributed from a Web server to his/her mobile terminal so that the trainee can improve his/her form by referring to the distributed data at any time and from any place, even on the court. The preliminary experiments were performed with the assistance of a university tennis class to compare a controlled group, who used mobile terminals, and a uncontrolled group, who did not use mobile terminals, In the present study, we (1) perform simultaneous outdoor measurement of racket movements and ground reaction

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forces, (2) measure visual data feedback to an individual trainee by means of a mobile terminal from a Web server, and (3) perform a system feasibility study with the assistance of a university tennis class to evaluate the performance of the proposed system.

2 System Configuration and Components

2.1 System Configuration

Fig. 1 shows a schematic diagram of the system configuration. The system provides tennis serving and stroke form information based of the measurement and analysis of ground reaction force and motion images. The ground reaction force is the reaction force generated by the ground, which is basically the reaction to the force that the body exerts on the ground. These data for a model player and individual trainees are stored on a Web server and then distributed to the mobile terminal of a trainee so that the trainee can improve his/her form by referring to the distributed data at any time and from any place, even on the court through a mobile terminal.

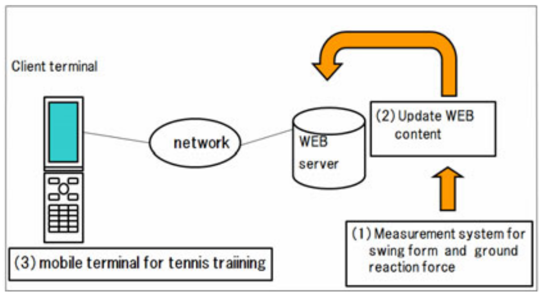
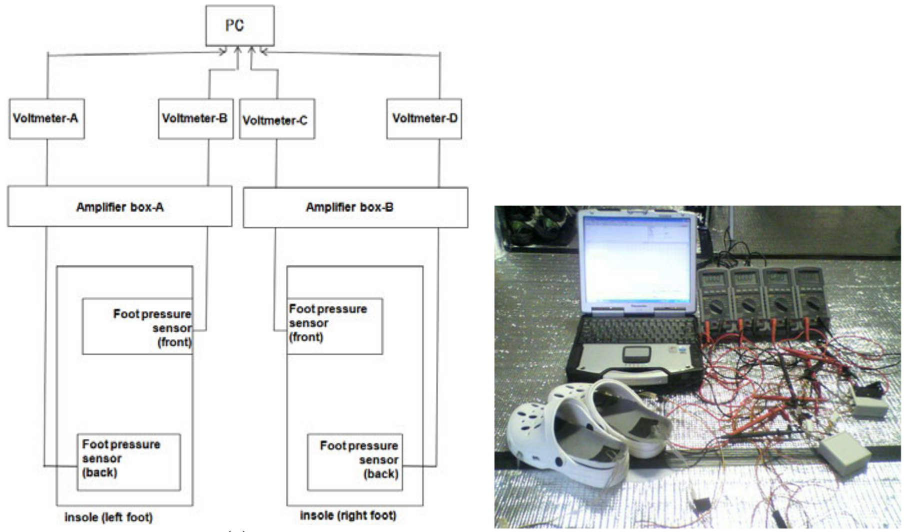


Fig. 1. Schematic diagram of the mobile terminal-based support system

2.2 Measurement System

The measurement system consists of two components for kinematic analysis: (1) video analysis of the racket swing form and (2) ground reaction force measurements. The former analyses the body posture, whereas the latter investigates the loads on the feet of the player. Two high-speed video cameras (Casio EXilim Ex-F1, Japan) operating at 300 fps were used to capture front and side views of the tennis player. Video analysis software (Octal Easy 8 Core, Ver. 5.5) was used to trace the position of the racket head at intervals of 0.5 s.

Fig. 2(a) shows the measurement set-up of the ground reaction forces. The vertical loads on the right and left feet were measured by piezoelectric elements (FlexiForce standard AZ201 sensor model, Nitta Corporation, Japan) at intervals of 0.5 s. As shown in Fig. 3(b), piezoelectric elements are attached to the front and back of the player's shoes so that the foot pressures on the piezoelectric elements, namely ground reaction forces, are converted to electric voltages. The outputs of the piezoelectric elements are amplified, digitized, and then sent to a personal computer, which visualizes the time sequential changes of the ground reaction forces.

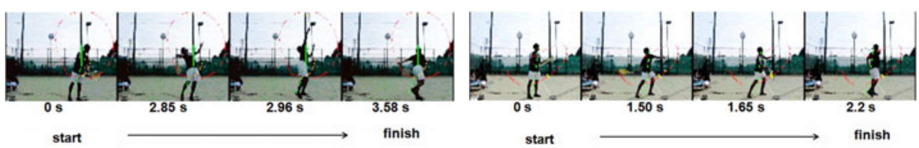


(a) (b)

Fig. 2. Ground reaction force measurement system. (a) Schematic configuration, (b) Photograph.

2.3 Measurement Results and Analysis

Fig. 3 shows time sequential photographs captured by a high-speed camera (300 fps). The traces of the racket movement are superimposed onto the photographs so that the racket movements can be easily recognized by the students. Figs. 4 and 5 show the measured ground reaction forces of the right and left feet during the serve and stroke, respectively.



(a) (b)

Fig. 3. Sequential photographs taken by a high-speed camera (300 frame/s) (a) serve, (b) stroke

Fig. 3(a) and 4 indicate the following process of the movement of the center of gravity of the body during serve.

(1) 0.5–1.5 s: The center of gravity of the body moves slightly as the ball is tossed into the air.

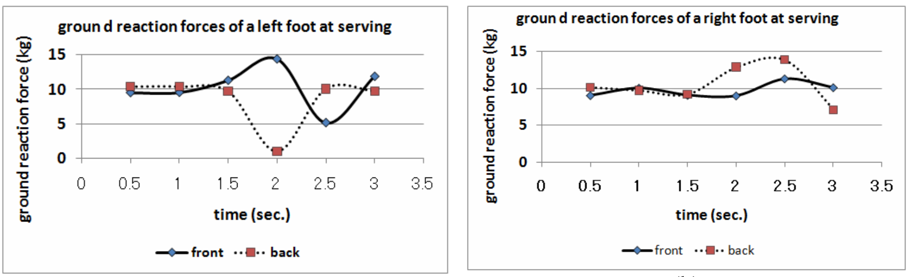
(2) ~2 s: The body weight on the left foot moves forward and the ground reaction force on the back part (heel) of the left foot is almost zero. In contrast, the body weight on the right foot moves backward in order to maintain balance.

(3) ~2.5 s: More body weight is loaded on the back part (heel) of the right foot just before a jumping serve.

Note that the ground reaction force data after 2.5 s is not measured correctly because the player has jumped off the ground.

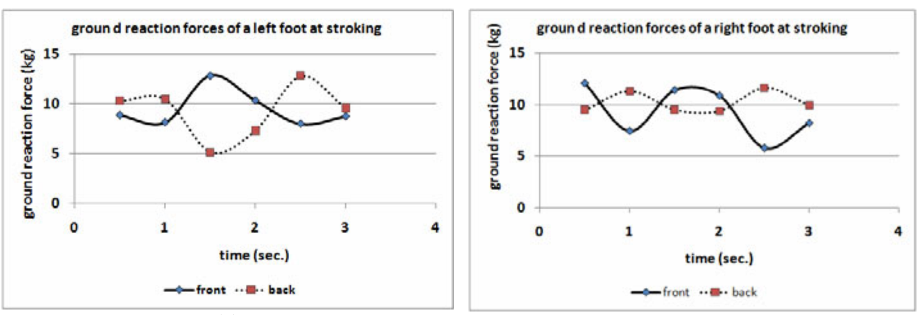
Fig. 3(b) and 5 indicate the following process of the movement of the center of gravity of the body during stroke.

(1) ~1 s: The body weight moves to the heels of the right and left feet.
(2) 1.5–2 s: The body weight shifts to the toes of the right and left feet.
(3) ~2 s: The body weight load on the left foot is greater than that on the right foot because the right heel leaves the ground.
(4) ~2.5 s: Both feet land on the court.



(a) (b)

Fig. 4. Measured ground reaction forces of the right and left feet during serve (a) right foot, (b) left foot



(a) (b)

Fig. 5. Measured ground reaction forces of the right and left feet during stroke (a) right foot, (b) left foot

2.4 Content Distribution from a Web Server to a Mobile Terminal

The measured and analyzed information on the serve and stroke forms are stored in a Web server so that a trainee can obtain his/her information by accessing the Web server through a mobile terminal. In addition to the data of the model player, the data of the individual trainee is distributed from a Web server to his/her mobile terminal so that the trainee can improve his/her form by referring to the distributed data at any time and from any place, even from the court.

Fig. 6 shows a Web site map, which consists of still pictures and videos of serve and stroke actions, as well as graphs of measured ground reaction forces. Data for trainees are measured during tennis class and are updated so that the renewed information is fed back to the trainee. The trainee can select instructive information of the trainee himself/herself, as well as that of other trainees and a model player as references.

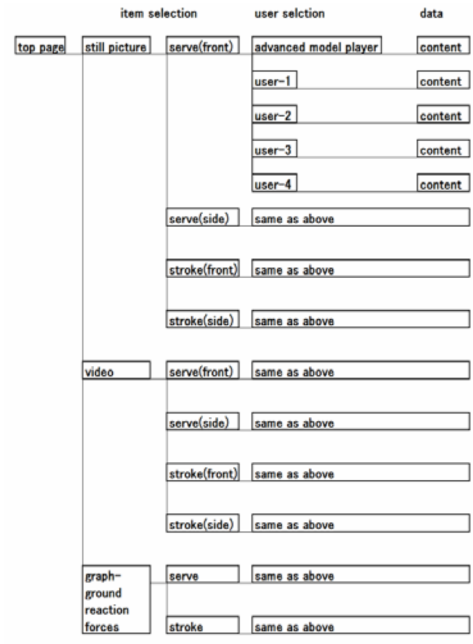


Fig. 6. Web site configuration

3 System Evaluation

3.1 Improvement of Serve and Stroke

The proposed system was evaluated with the assistance of a university tennis class during the autumn of 2010. The controlled group, who used mobile terminals, and the uncontrolled group, who did not used mobile terminals, are each made up of four beginner students. The following measurements were carried out every two weeks in order to investigate the improvement in basic tennis skills, namely, serve and stroke actions.

1) Video capture of serve and strike forms from the front and side.
2) Ground reaction force measurement for serve and stroke.
3) Test to count the number of successful serves among 20 trials, where the student is requested to serve alternately to one of the divided target zones, the center zone, and the cross service zone, 20 times.
4) Test to measure the frequency of rally strokes with an advanced tennis player in a cross stroke position.

The above data for the controlled group were uploaded to the mobile terminal wave pages within a week after class. The control group students were instructed to view the uploaded web pages so that they can modify their serve/stroke actions. The improvement of the students in the controlled group and uncontrolled group was evaluated by means of the above tests, which were performed three times every two weeks. The groups showed different improvement trends.

Fig. 7 shows the average improvement for the serve and stroke actions for the controlled group (solid line) and uncontrolled group (dashed line). The initial test results, indicated by a frequency of 0, are shown for reference. The difference in the average success frequency of serve present and previous tests is used as an improvement index. In order to illustrate the distribution of data, 25, 50, and 75 percentile values are indicated in the figure. Fig. 7(a) shows the average improvement in serve for the controlled and uncontrolled groups. The initial test results, indicated by a frequency of 0, are shown for reference. The difference in the average success frequency of serve of the present and previous tests is used as an improvement index. Thus, the present test result is worse than the previous one, the improvement index becomes negative, In order to illustrate the distribution of the data, 25, 50, and 75 percentile values are indicated in the figure. Fig. 7(b) shows that, similar to the case for the serve action, the improvement in the stroke action for the controlled group, who used mobile terminals, is greater than that for the uncontrolled group. Fig. 7 shows that the improvement for the controlled group is greater than that for the uncontrolled group.

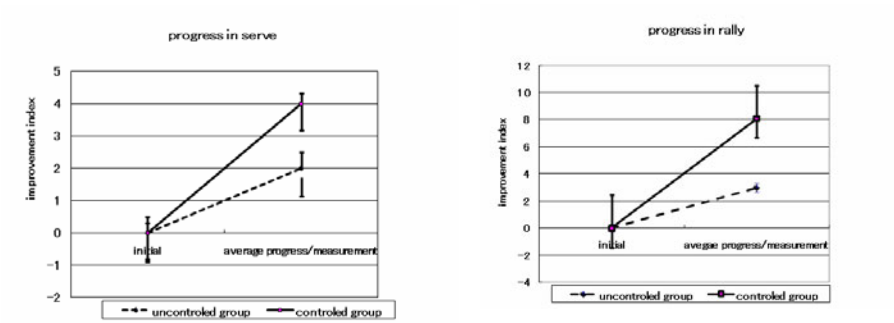


Fig. 7. Improvement in (a) serve and (b) stroke actions

3.2 Subjective Evaluation by Students

In order to investigate the usability of the mobile terminal-based system, the system was evaluated by students through the semantically differential (SD) method. Fig. 8 shows

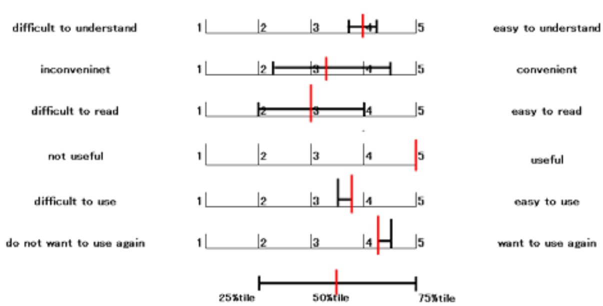


Fig. 8. Subjective evaluation by students

the subjective evaluation by the students. The figure shows the 25, 50, and 75 percentile values. This figure indicates that the proposed system is useful to the students, although there is room for improvement of the visual representation at the terminal.

4 Conclusion

The present paper proposes a system by which to measure the serve and stroke forms of tennis players by measuring ground reaction force and through video analysis. The following results are obtained.

(1) Preliminary experimental results confirmed the technical feasibility of the simultaneous outdoor measurement of racket movement and ground reaction forces.
(2) The improvement in serve and stroke in a controlled group, who used mobile terminals, was larger than in the uncontrolled group, who did not use mobile terminals.
(3) A usability test has revealed that the proposed mobile terminal-based system is useful for students, who reported that they would like to use the system again, although there is room for improvement of the visual representation at the terminal.

References

1. Liu, J., Pan, Z., Li, X.: An accelerometer-based gesture recognition algorithm and its application for 3D interaction, Comput. Sci. Inf. Syst. 7(1), 177–188 (2010)
2. Nosu, K., Otsuka, T., Okura, T., Hirai, Y.: An immediate feedback video production system for a table tennis class. Journal of Visualization 12(1), 7–8 (2009)
3. Nosu, K., Yabuzaki, Y., Yamanaka, K.: Evaluation of baseball pitching form by ground reaction force measurement and video analysis. Journal of Visualization 12(4), 293–294 (2009)
4. Wanatabe, K., Horikawa, M.: Kinematical analysis and measurement of sports. IEEE Trans. Systems, Man and Cybernetics-Part A 36(3), 549–557 (2006)
5. Pan, Z., Xu, W., Huang, J., Zhang, M., Shi, J.: Easybowling: a small bowling machine based on virtual simulation. Computers & Graphics 27(2), 231–238 (2003)
6. Wang, J.R., Parameswaran, N.: Survey of sports video analysis: research issues and applications. In: Proceedings of the Pan-Sydney Area Workshop on Visual Information Processing, VIP 2005, pp. 87–90 (2005)

Developing a Complexity Problem-Based E-Learning Model: A Longitudinal Qualitative Case Study of a Six-Year Course Blog

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Abstract. The purpose of the study was to examine a six-year course blog and establish a collaborative Problem-based e-learning (PBeL) model by using complexity theory as theoretical framework. The results identified that complexity theory outlines four elements to establish a complex PBeL model which includes: (1) dynamic interaction addresses on the importance of increasing interactions between instructors, students, and administrators, and universities; (2) co-evolution identifies that both instructors and students need to modify their concepts on learning time, learning styles, feedback, electronic interaction, and motivation; (3) mutual-adaptation points out that multidisciplinary cooperation are viable to explore possible real-world problems and current issues in PBeL, and (4) self-organization strongly recommends that service providers and student organizations shall start to advocate and develop PBeL programs and begin to discuss updated course-related issues. The findings conclude that complexity theory is a valuable theory for developing a complex PBeL model to facilitate successful learning environment.

Keywords: blog, problem-based learning, e-learning, complexity theory, case study, qualitative research, Web 2.0.

1 Introduction

Problem-based learning (PBL) has been widely accepted and used across disciplinary professions in higher education. It is a powerful learned-centered instructional approach by providing complex real-life problems for learners to actively engage in investigation and inquiry. PBL is an instructional/curricular learner-centered approach that empowers learners to integrate their knowledge and skills in research, theory and practice and to develop viable ways for defined problems [1]. Recent studies also pointed out that PBL can improve learners' problem-solving skills, diagnostic skills, deepen understanding of content knowledge with its foundations in constructivist theories [2-5].

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The inclusion of instructional support and environment is a critical element of a successful PBL design which can be facilitated via the advancing of "Web 2.0" technologies. Since blogging has become one of most popular Web 2.0 applications, Problem-Based e-Learning (PBeL) has great potential to offer a better learning environment for higher educators. Blogs provided an interactive platform for instructors to probe questions and students to publish their comments and answers to interact with the instructor and other classmates [6].

There are four major characteristics that make blogs useful tools for teaching and learning [6]. First of all, blogs are able to facilitate reading and motivate learning because "personal diary-like-format websites" are easy to use and open for everyone read [7]. Second, blogs are like communities which are constructed by people who share mutual interests and collaborate common objectives, regulations, and formats [6]. Third, blogs are always full of resources and a variety of multimedia information by providing hyperlinks [6]. It makes learners have opportunities to have audio and visual materials to enhance learning motivation. Finally, blogs provide a learning space which allow learners to learn by creating a relatively learner- centered environment [6, 7]. Therefore, with those four characteristics, blogs can be seen as virtual classrooms that are endowed with a friendly environment for PBeL.

2 Methodology

A seven-year course blog, Therapeutic Recreation/Recreation Therapy (http://blog.roodo.com/ tr1314 and http://blog.yam.com/tr1314), was selected as research object in the study. The research method was qualitative case study. The targeted blog was built at http://blog.roodo.com/tr1314 and began to offer after-class discussion forum, homework management platform, and feedback for sport- and leisure-related courses since August 2005 (See Figure 1). It totally offered 66 courses within six years. In 2007, the blog was forced to change the domain name due to the commercial mergers and acquisition. It changed it domain to http://blog.yam.com/tr1314 since 2007 (See Figure 2). However, existing blogs and students'

Fig. 1. Therapeutic Recreation/Recreation Therapy Blog at Roodo®

Fig. 2. Therapeutic Recreation/Recreation Therapy Blog at Yam®

interactions (2005~2007) still kept at the original domain because of difficulty in transferability. According to visitor counters, more than 60,000 visitors/learners/students viewed the blogs and thousands of learners and visitors replied and gave feedback to assignments, problems, and questions in those courses.

2.1 Research Design and Research Question

The study applied qualitative, case study methodology. In order to have deep understanding of the blog and PBeL in this case, qualitative methodology is considered to be the best methodology to develop a rich, thick description of the case. This approach meets the descriptive nature of the research questions and gives the best picture of the PBeL environment studied. Because this study is about the characteristics of PBeL environments being studied qualitative inquiry best fits in this framework.

Past complexity literature has been reviewed to analyze and provide evidences on constructing a theoretical framework to understand this case. The study aims to identify future course blogs to develop a better learning environment and to expand multiple learning approaches for PBeL.

2.2 Data Collection

Two blogs were examined and analyzed since 2010. Students' reply, feedback, and interactions were collected and imported to a computer assisted qualitative data analysis software (CAQDAS), QSR*NVIVO 7. Data were gathered in several parts including informal and formal interviews of students, field notes, bloggings and feedback, homework, interactions completed by students, reflective journal logs, instructors' comments and notes.

2.3 Complexity as Theoretical Framework

This paper is to explore a relatively new educational theory to discuss how it is being applied to PBeL. Complexity theory is a revolutionizing the way scientists look at the world and has been pervasively applied in a variety of professions to adapt multiple environmental changes and multidisciplinary collaboration in recently research. Evolved from Chaos theory and Lorenz attractor (figure 3), complexity theory that emphasizes uncertainty and randomness constructs a non-linear dynamic system that traditional organizational theories are inability to explain and predict. Mathews, White & Long [8] stated,

> *Although traditional approaches to the explanation of organizational change and transformation processes are limited and have proven unsatisfactory in guiding both research efforts and applied management practices, it is suggested that these limitations may be lessened at a theoretical level by developments in the complexity sciences…The complexity approach offers a fundamentally new way of conceptualizing many of the apparent paradoxes confronting organization theory and analysis [8, p.439].*

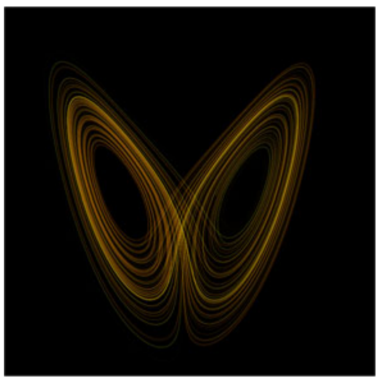

Fig. 3. An icon of chaos theory - the Lorenz attractor (Source: Wiki Foundation)

Complexity theory makes use of paradoxical explanations when being used to explain the survivability and adaptability of biological system [9]. It provides a framework which conflicts directly with the traditional metaphors or organizations and parallels the replacement of metaphors. In this study, we use it as theoretical framework to analyze the targeted blog.

2.4 Limitations Arising from the Research Methodology

Several matters arising from the research methodology may have impacted on our final results. The lack of directly empirical data to support the model may be criticized due to the nature of exploratory study design. However, with solid theoretical framework support and critical literature review, the study still provides valuable contributions to stipulate possible practical solutions for PBeL from qualitative perspective.

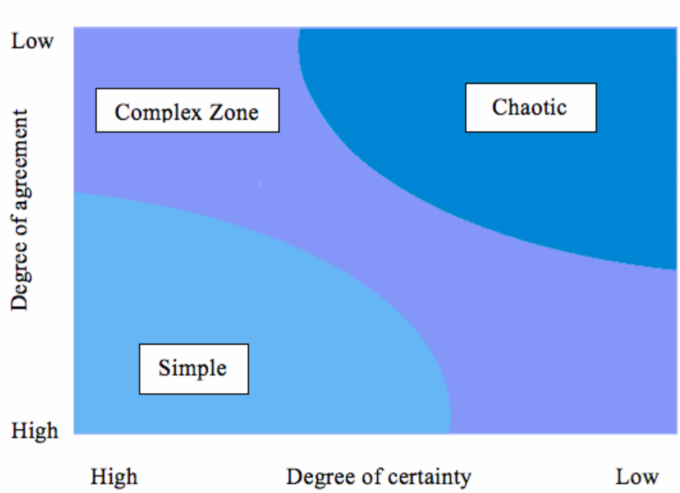

Fig. 4. Complexity theory (Adapted from Plsek & Greenhalgh [10])

Another potential challenge would question on the legitimacy of borrowing concepts of complexity theory as a metaphors from the physical and biological sciences. In order to overcome this challenge, a great amount of previous studies on complexity theory have been critically reviewed and satisfactory in predicting solutions on multidisciplinary collaborations because complexity theory is a new view of looking at how complex environment, structures form, adapt, and change. The academic nature of the research was emphasized in this study.

3 Results and Discussion

According to the complexity theory, a complexity PBeL model was developed by a collection of students, instructors, visitors, and other possible participants with freedom to act in ways that are not always totally predictable, and whose actions are interconnected so that the action of one part changes the context for other individuals. The model illustrates several levels of the system. First of all, the behavior of all participants in the process of PBeL is determined partly by an internal set of rules based on past experience and partly by unique and adaptive responses to new stimuli from the Internet environment. Second, the web of relationships between instructors and students in which participants exist contains many varied and powerful determinants of their beliefs, expectations, and behavior. Third, through the blog, participants and their immediate learning interactions are further embedded within wider social, political, and cultural systems which can influence learning outcomes in entirely novel and unpredictable ways. Finally, a small change in one part of the blog may lead to much larger changes in learning experiences through amplification effects. Figure 5 shows the complexity PBeL model in which the zone of complexity illustrates four major characteristics of PBeL.

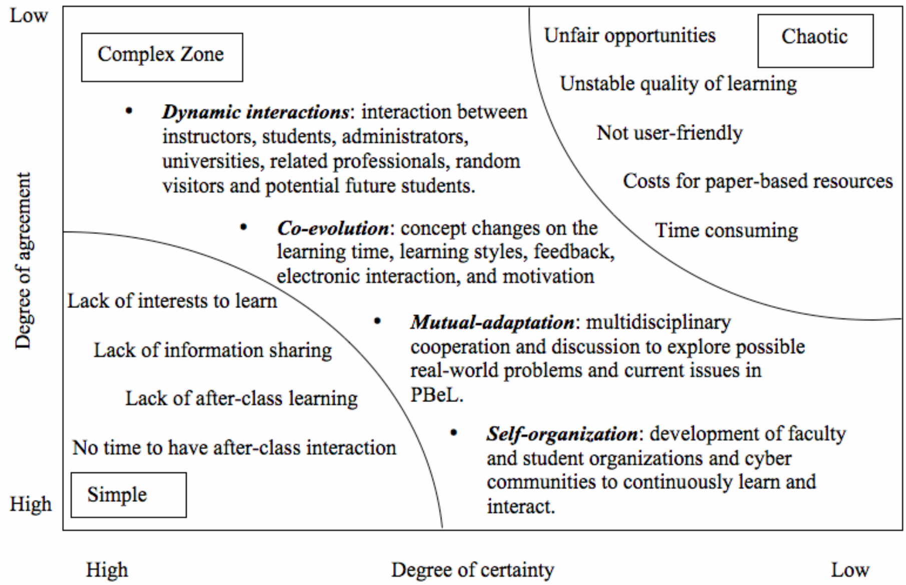

Fig. 5. Complexity model of Problem-Based E-Learning

3.1 Dynamic Interaction

Dynamic interaction addresses on the importance of increasing interactions between interaction between instructors, students, administrators, universities, related professionals, random visitors and potential future students. For example, the instructor got an email from a high-school student,

> *"Two years ago, I googled around and found your course blog. In the past two years, I kept reading your therapeutic recreation/recreation therapy blog. Now, I am highly interested in your profession. I have made up my mind to apply your program after my graduation and wanna join your profession. Look forward to attending your class in person in the near future."*

3.2 Co-evolution

Co-evolution identifies that both instructors and students need to modify their concepts on the learning time (e.g., after school hour, midnight, early morning), learning style (e.g., needing a great amount of multimedia to keep concentration), feedback (online electronic interaction), and motivation (e.g., computer attachment, video-/audio-information). One student expressed his experience in PBeL and said,

> *"I like the course blog very much. I can write and read my course material any time that I want. I always read them and write them in the midnight because I have lots of ideas and energy then.*

Additionally, I love to write my homework on the blog because I don't have printer and don't want to saw the trees ^_^ … Also, with the blog, we cannot copy our assignments each other because you can google and found that…ha ha ha… "

3.3 Mutual-adaptation

Mutual-adaptation points out that multidisciplinary cooperation and discussion to explore possible real-world problems and current issues in the profession. In addition, higher educators in course-related services (e.g., e-learning, faculty development, and technology service, and library) need to cooperate with office of academic affairs to facilitate this PBeL interaction. The instructor who have maintained this course blog in the past six years stated,

"I noticed that course blog made me have to update my information everyday. In the past, my professors could prepare teaching materials once and used them for more than ten years. But now, with the e-learning system, I cannot do it anymore. Because I use lots of questions and problems based on news clips, students won't know those news which happened last year. Therefore, I have to keep searching news and giving update news, problems, questions every semester. Professors who never use course blogs to teach may think that it is easy but, actually, they never understand that it is so painful and time-consuming, really…"

3.4 Self-organization

Self-organization strongly recommends that service providers (e.g. instructors and university) and student organizations shall start to advocate and develop PBeL programs and begin to discuss issues, such as course objects, contemporary trends, and being aware of updated course-related news and issues. The instructor who maintains this course blog expressed,

"I had no idea and did not know where it [the course blog] would go in the first two years. Sometime I doubt whether it would success. Then, I met some colleagues who also taught courses by using course blog and have learned so much from them. In addition, I transferred to a different university three years ago and this university really encourages faculty to facilitate e-learning course and to construct course blogs. The university provides lots of resources, tools, applications, and platforms that are very useful to my teaching. Of course, I can maintain my course blog much easy by using those tools and applications…"

In addition, a group of graduate students began to "self-organize" and started a non-profit organization, Taipei Transition and Leisure Services for People with Disabilities. With the learning experience of this course blog, they developed their discussion group, a closed Internet community, for the organization by the support of the instructor. Figure 6 is the self-organized discussion group.

Fig. 6. Graduate students' self-organized discussion group

4 Conclusions

Recently Web2.0 technologies have impacted our life tremendously to the Internet and along with complexity PBeL models which exploit collaboration and co-creation activities in higher education environment. The findings conclude that complexity theory is a viable and valuable theory for developing a complex PBeL model to facilitate successful learning environment. Further research plans include studying quantitative approach of PBeL and its novelty effect, as well as understanding learners' satisfaction and learning behavior changes in the PBeL process. In addition, because Web 2.0 approach that includes asynchronous material contributions and discussions, synchronous activities (e.g., gaming and chatting) should foster learners' proactive participation at their leisure, involving learners via PBeL could be very fruitful [11].

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References

1. Savery, J.R.: Overview of problem-based learning: Definitions and distinctions. The Interdisciplinary Journal of Problem-based Learning 1(1), 9–20 (2006)
2. Gallagher, S., Rosenthal, H., Stepien, W.: Content acquisition in problem-based learning. Gifted Child Quarterly 36(4), 195–200 (1992)
3. Schmidt, H.G., Machiels-Bongaerts, M., Hermans, H., ten Cate, T.J., Venekamp, R., Boshuizen, H.P.: The development of diagnostic competence: Comparison of a problem-based, an integrated, and a conventional medical curriculum. Academic Medicine 71(6), 658–664 (1996)

4. Dods, R.F.: An action research study of the effectiveness of problem-based learning in promoting the acquisition and retention of knowledge. Journal for the Education of the Gifted 20(4), 423–437 (1997)
5. Stewart, T.M., MacIntyre, W.R., Galea, V.J., Steel, C.H.: Enhancing problem-based learning designs with a single e-learning scaffolding tool: Two case studies using Challenge FRAP. Interactive Learning Environments 15(1), 77–91 (2007)
6. Yang, S.H.: Using blogs to enhance critical reflection and community of practice. Educational Technology & Society 12(2), 11–21 (2009)
7. Efimova, L., Fiedler, S.: Learning webs: Learning in weblog networks. In: Kommers, P., Isaias, P., Nunes, M.B. (eds.) Proceedings of the IADIS International Conference Web Based Communities 2004, pp. 490–494. IADIS, Lisbon (2003)
8. Mathews, M.K., White, M.C., Long, R.G.: Why study the complexity sciences in the social sciences? Human Relations 52, 439–462 (1999)
9. Grobman, G.M.: Complexity theory: A new way to look at organizational change. Public Administration Quarterly 29(3), 351–384 (2005)
10. Plsek, P.E., Greenhalgh, T.: The challenge of complexity in health care. British Medical Journal 323, 625–628 (2001)
11. Angehrn, A.A., Luccini, A.M., Maxwell, K.: InnTube: a video-based connection tool supporting collaborative innovation. Interactive Learning Environment 17(3), 205–220 (2009)

An Online Summary Writing System Combining with Concept Mapping and Annotation Sharing

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Abstract. This study integrated concept mapping and annotation sharing of an online summarization learning environment, this approach employed concept mapping as a scaffolding, which learners grasped the key points. It helped learners complete concept mapping and wrote summary via the framework of the completed concept mapping. Research findings indicate that through concept mapping correction test participants' performance in summarization efficiency is significantly different from that of test participants who only read the article and write the summary afterwards. Among test participants who used the correction-type concept mapping with the annotation mechanism, 80% agreed that concept mapping helped them in grasping the key points of the article. With the function and effect of the online summarization learning environment that integrates concept mapping and annotation sharing, 72% of the test participants were agree or very agree.

Keywords: concept mapping, annotation, summarization.

1 Introduction

Summarization is a very important practice to equip learners with the ability to concisely and clearly take hold of the key points of what they read and hear. Concept mapping is similar to the context-integrated network learning method. It is also a meaningful organized learning method. It expands from studies of single concepts to encompass learning of the meaning of concept within context of the sentence. Not only a point-oriented study, has it covered learning of the "facet-oriented study" [1]. Meanwhile, annotation is a word-processing procedure during the reading activity that highlights the important information from the article. Hidi & Anderson [2] indicated that summing up the information was sufficient to represent the content of an article and it was a very effective approach to help readers understand the article. In order to overcome the difficulties facing learning during summary writing, this study utilized concept mapping to enable them to comprehend the content of their learning in a

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computer-network-based online learning environment. In conjunction with annotation sharing among students, it helped learners complete concept mapping and made up for their inability to fully grasp the learning content. Finally, based on the framework of the completed concept mapping learners engage in the activity of summary writing.

2 Literature Review

2.1 Studies Related to Summary Writing

Smith [3] identified common themes to emerge from a burgeoning and diverse literature, which included reports and summaries available on the Internet. There was insufficient evidence to identify the actual impact of such technologies upon learning either in terms of classroom interaction or upon attainment and achievement.

Palaigeorgiou [4] developed eVerNotes, an application that facilitated verbatim note-taking and enables the creation of multiple notes' associations through an intermediate hierarchical structure. Students who were willing to negotiate their study model exploited eVerNotes' functions and praised its contribution to improving their comprehension and the studying process. The results constituted a positive indication for the viability of applications that supported electronic verbatim note-taking.

2.2 Studies Pertaining to Online Concept Mapping

Studies on experimental teaching through concept mapping have been developed for nearly 20 years. In addition to biology classes, scholars have incorporated it with teaching and learning of social, natural and medical sciences. It has also been employed in other fields such as reading comprehension, literature appreciation and Internet information search. Research outcomes indicate through the teaching process that utilizes concept mapping, learners can attain better learning achievement [5]-[8]

Stoyanov and Kirchner [9] indicated that used concept mapping approach to define the characteristics of an adaptive learning environment. The effectiveness and the efficiency of the method are attributed to the support that it provides in terms of elicitation, sharing, reflection and representation of knowledge. It produced valuable results in a very short time as compared to classical techniques such as questionnaires and interviews.

2.3 Researches Pertaining to Online Annotation Learning Platform

Annotation helps learners memorize, consider and clarify the content [10]. In other words, it underscores the highlights of the article for memorization and helps readers think as they note their opinions, questions and reasons. The content of the article is illuminated when they present it in their own words.

3 System Design and Operation

3.1 System Framework

In this study, learners were situated in a network-based summary writing environment. Consisting of the client, server and database system, it was a 3-tier master-slave framework. At the client end, learners through the network browser issue requested to the server, which in accordance with the nature of the request decided whether to link with the database system or not. Once it was deemed necessary to request data from the databank, the record of the databank was retrieved through the CGI (Common Gateway Interface) program. Following the processing, the response to the request submitted from the client end was issued, and learners would be able to see responses from the server through the network browser.

According to the objective of this study, the online summary writing learning environment of this study contained two main modules: Error-correction concept mapping and annotation sharing modules. The operational outcomes of the error-correction concept mapping module are depicted in Figure 1.

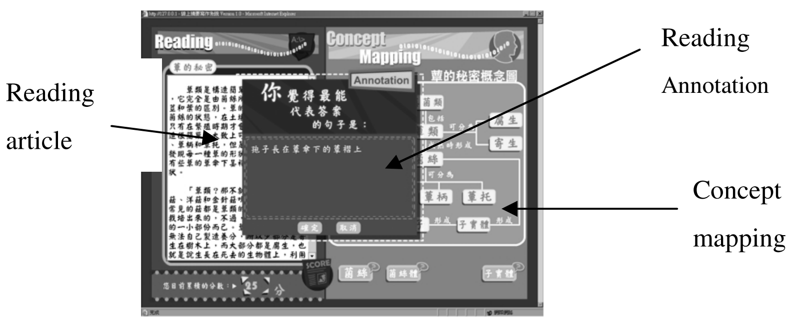

Fig. 1. Error-Correction Concept Mapping Module Screen and Annotation Sharing Module Screen

Concept mapping: Learners entering the online summary writing environment select summary writing and go into the concept mapping stage. Annotation sharing: In the concept mapping stage learners who experience difficulties with construction of a theme will be led by the system to the annotation sharing phase. Through observing other learners' annotation of the theme, they resolve their own problem. Those who overcome the difficulties will return to the concept mapping stage to complete the concept map. Writing: This is the last stage of online summary writing. The completed concept mapping is used as the writing framework to help learners with summarization (Figure 2).

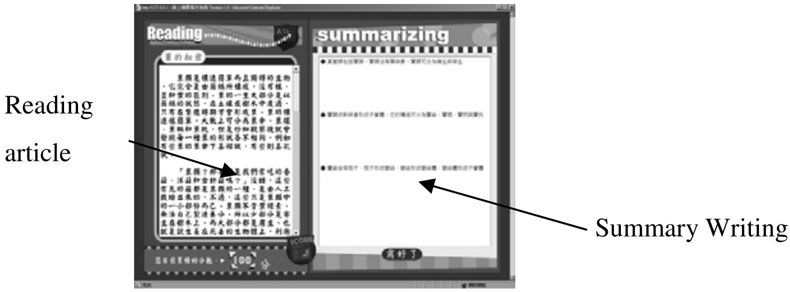

Fig. 2. Writing Stage of Online Summarization Learning Environment

4 Findings and Discussion

The outcome of the Levene test equation of the error variance (a.k.a the homogeneity test of the variable) indicated the error variances of the independent variable of different groups were homogenous (F = 2.662, p = .077). After removing the impacts of the pretest score (covariate variable) and posttest score (dependent variable), the impact of the independent variable on the dependent variable was significant (F=6.561, p=.002) based on the efficiency test. The fact that the F value reaching the significant level indicated those participants' posttest scores differed among different groups (Table 1). Posterior comparison reveals that Experiment Group 1 was better than Control Group (M= .032 vs. .024) and that Experiment Group 2 was also better than Control Group (M= .033 vs. .024). Note that no significant difference was found between Experiment Group 1 and Experiment Group 2. Table 2 showed highlights of adjusted mean scores of the groups and posterior comparison.

Table 1. Highlight of Co-Variable Analysis

Source of Variation	SS	df	MS	F	Posterior Comparison
Co-Variable (pretest score)	.000	1	.000	.340	
Group (learning model)	.001	2	.001	6.561**	Experiment 1> Control
Error	.006	70	.000		Experiment 2> Control

** p<.05

Table 2. Highlights of Adjusted Mean Scores of the Groups and Posterior Comparison

	Experiment Group 1 (M=.032)	Experiment Group 2 (M=.033)	Control Group (M=.024)
Experiment Group 1	-----	.735	.004**
Experiment Group 2	.735	-----	.001**
Control Group	.004**	.001**	-----

**p<.05

5 Conclusions

Based on its attempt to help learners resolve summary writing problems in the online learning environment, this study demonstrates an online summary writing learning model that incorporates concept mapping, annotation and computer-assisted cooperative learning. Experiment outcomes indicate through correction of the errors presented by the concept mapping, participants' performance in summarization efficiency is significantly different from that of test participants who only read the article and write the summary. Participants' performance in reading comprehension via correction of the errors presented by the concept mapping is also significantly different from that of test participants who only read the article and write the summary indicating this system significantly helps enhance pupils' summary writing ability.

References

1. Yu, M.N.: Meaningful Learning – A Study of Concept Mapping. Shang Ding Publication House, Taipei (1997)
2. Hidi, S., Anderson, V.: Producing written summaries: Task demands, cognitive operations, and implications for instruction. Review of Educational Research 56, 473–493 (1986)
3. Smith, H., Higgins, S., Kate, W., Jen, M.: Interactive whiteboards: boon or bandwagon? A critical Review of the Literature 21(2), 91–101 (2005)
4. Palaigeorgiou, G.E., Despotakis, T.D., Demetriadis, S., Tsoukalas, I.A.: Synergies and barriers with electronic verbatim notes (eVerNotes): note taking and report writing with eVerNotes. Journal of Computer Assisted Learning 22(1), 74–85 (2006)
5. Oughton, J.M., Reed, W.M.: The influence of learner differences on the construction of hypermedia concepts: A case study. Computer in Human Behavior 15, 11–50 (1999)
6. Chang, K.E., Sung, Y.T., Chen, S.F.: Learning through computer-based concept mapping with scaffolding aid. Journal of Computer Assisted Learning 17(1), 21–33 (2001)
7. Odom, A., Kelly, P.V.: Integrating concept mapping and osmosis concepts to high school biology students. Science Education 86(6), 615–635 (2001)
8. Lee, Y.J.: Concept mapping your Web searches: a design rationale and Web-enabled application. Journal of Computer Assisted Learning 20(2), 103–113 (2004)
9. Stoyanov, S., Kirchner: Paul Expert concept mapping method for defining the characteristics of adaptive E-learning: ALFANET project case. Educational Technology Research and Development 52(2), 41–54 (2004)
10. Ovsiannikov, I.A., Arbib, M.A., Mcneill, T.H.: Annotation technology. International Journal of Human-Computer Studies 50, 329–362 (1999)

Web Programming Education through Developing Online Shop Web Application

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Abstract. A class of web programming held in a university is introduced. After learning and practicing PHP and SQL languages, students develop online shopping web sites. After completing the development, the web applications are run in university intranet, and then, students enjoy playing online shopping by visiting some online shops developed by other teams in class. Web programming skills are well acquired by student through experiencing realistic web application development.

Keywords: Web Programming, Hands-on Learning, Higher Education, Online Shopping.

1 Introduction

Hands-on learning is an effective way for students to understand real world technologies (e.g., Dewey 1938). By only from lectures or practices in class (cf. Dale 1946), it is hard for students to imagine how subjects learned at school are used in real world and why they are important, as university students have not experienced professional jobs yet. As a result, motivation is low and achievements are not enough. In this paper, hands-on type project based learning of web programming through developing online shop web applications in intranet environment is introduced. Students play shopping during class as consumers and as owners of online shops developed.

2 The Course Design and Syllabus

Throughout 4 academic years of undergraduate program of the media informatics department for bachelor degree of informatics, the areas of information and communication technology, computer programming, multimedia contents authoring, and some additional subjects are learned. Programming and authoring for the Internet and World Wide Web are the most important skills to be acquired. Starting from HTML and CSS, Java Script, PHP, SQL are learned as well as other IT subjects and

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programming languages of C and Java. The objective of the subjects “Web Programming” and “Database and Network” reported in this paper is to acquire programming skills for Web applications on Linux, Apache, MySQL, and PHP (so called LAMP) environment.

1 year (30 weeks, 90 minutes per week) is allocated for these 2 subjects in total. At the first half, basic syntax and common libraries of PHP programming are taught. At the second half, project teams consisting of 6 members each, make their own online shopping site.

After completing the development, students enjoy playing online shopping by visiting some online shops developed by other teams in class. A customer visits the online shop web sites, selects products, puts into a shopping cart, and finally checks out to finish the shopping. Products are shown in JPEG images taken or drawn by students.

Implementing shopping cart algorithm is slight difficult for students, thus sample scripts and detailed explanations are supplied in class. At the end of the course, students do short presentation and submit development documents and source codes of scripts and data.

3 Result, Evaluation, Summary, and Future Works

At the end of the class, questionnaires were done. In summary, students enjoyed the development (62%) and answered that the development of web application was effective to acquire web programming skills (90%). Also, they consider that team development is better than individual development to increase ability (46% vs. 26%). In addition, 86% of students consider that edutainment is effective. From observation of students’ activities, playing shopping looks fun. It looks contributing to raise students’ motivation. The class looks successful in terms of effectiveness.

In summary, hands-on learning for students to experience team based web application development was done. Students have developed online shopping applications written in PHP. After completing the development, students enjoy to play online shopping by visiting some online shops developed by other teams in class. Web programming skills are well acquired by student through experiencing realistic web application development.

Additional original scripting libraries to realize more realistic playing are being implemented. An example library is a banking system to realize money payments between accounts.

References

1. Dewey, J.: Experience and Education. Macmillan, Basingstoke (1938)
2. Dale, E.: Audio-visual methods in teaching. The Dryden Press, New York (1946)

e-Adviser: A Web-Based Academic Support System for High School Students

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Abstract. Academic adviser is a very important and time-consuming effort in all educational system. In our research, the e-Adviser system is proposed to provide immediate information for the high school academic advisers to support students in their department selection problem. This system includes questionnaire agent, portfolio agent, assessment agent and department-recommend agent. The rule-based subsystem considers all the relevant factors gathered by different databases including student academic portfolio, personal interest, learning attitude. The attitude test developed by education experts are used in this research.

Keywords: e-portfolio, academic adviser, department selection.

1 Introduction

An academic adviser is very important in various school activities. Experts (teachers) have more adequate diagnose criteria than novices (students) in school career recommendation (van Ophuysen, S. ,2006). An advisee may need advice on academic experience, research skills and high level qualifications (Bateman and Kinmonth 2001). The communication between adviser and advisee influences for subsequent productivity and self-efficacy for PhD students (Paglis, Green et al. 2006). An guidance program in secondary school tried to generate dialogue among adviser, teacher and students to induce a life project for students in curriculum performance and labor market possibility(Vega, Garcia et al. 2010). However, the integration of decision making process is a challenge for school adviser. The adviser may not have enough expertise or skills to play his role. An adviser requires more information on a knowledge base to assure his support needs. Information and communication technology which can promote the dialogue after activity organizing and structuring offers a range of possibilities.

The high school graduate students in Taiwan face a department selection problem. In this paper, we would like to introduce a web-based academic system to support high school adviser in pursuing student's best benefits.

2 Literature Review

In order to set up good theoretical basis for research, this chapter will study aimed to explore the literature review.

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Student's behavior may be hidden beyond curriculum performance. E-portfolios can be a useful way of tracking the hidden curriculum as it evolves (Phillips, 2009). Advisors reported students' reflective responses to focused questions in an students' journaling as a part of e-portfolio contribute valuable understanding about students' thinking and attitudes (Bashook and GeRula, et al., 2008). If e-portfolio is fully implemented, the contribution in students/advisers decision will be more significant. Personality traits have direct and moderating effects on career decisiveness and its antecedents. In addition, the influence of personality and the antecedents of career decisiveness differ in the three countries examined (Gunkel and Schlaegel, et al., 2010).

3 Research Method

The main components in system architecture include:

1. Questionnaire Agent: This agent provides two on-line questionnaires, the Interest Meters (IM) of CEEC and Lai's Personality Test. There are 6 occupation patterns (R, I, A, S, E, C) and 201questions in Interest Meters. Each question is answered by student in Likert's 4-point scale. Lai's Personality Test includes 130 questions in 13 categories. The users' original answers are stored in Questionnaire Results database.
2. Assessment Agent: The assessment agent is to evaluate users' occupation aptitude and personality. The top three IM patterns are calculated and the similarity of the patterns are evaluated then assigned to a specific occupation aptitude and a table of relevant occupation and explanation are listed. If the occupation aptitude is not obvious in IM, Lai's personality Test is used as supplement information. The analysis result is stored in Learners Portfolio database.
3. Portfolio Analysis Agent: Besides occupation aptitude and personal characteristic data, the Learners' Portfolio database collects learner's school activity information including curriculum performance, club participation, professional certification, etc. Portfolio Analysis agent show individual's portfolio or selected report in groups.
4. Rule-based System: The rules include the past expert department recommendation and the connection with personal result of Interest Meters of CEEC and Lai's Personality Test. Personal Information database can provide appropriate department for each student and conform to their requirement.
5. Department Recommend Agent: The agent provides menu of departments that suit each student for advisers and students to support their department selection decision in accordance with their personal information (e-portfolio) with the scale of questionnaire result. Advisers or academic teachers would be able to explain and analysis the menu of departments for learners.

The e-portfolio was implemented by high school teachers including curriculum and extracurricular activity. Graduate students in high school fill out the Interest Metrics of CEEC and receive the analysis results. If the result is not conclusive, the Lai's Personality Test is necessary to finish. The analysis results and e-portfolio for every student are integrated to a report to adviser. Adviser may retrieve student's individual report or a class summary report. The recommendation process is proceeding when the department selection choice was supported by adviser. The adviser bring up the department list which is considered best under students career aptitude, personality, ability and other relevant factors. The decision making support process is gathered to form the expert rule.

4 Conclusion

This paper proposed a prototype for a web-based adviser support system for high school students in their department selection problems. The following work is to implement the system to assure the planning process is considerable and supportive.

References

1. Bashook, P.G., GeRula, M.H., et al.: Impact of student reflective e-portfolio on medical student advisors. Teaching and Learning in Medicine 20(1), 26–30 (2008)
2. Bateman, H., Kinmonth, A.L.: Journeys and pathways: exploring the role of professional development advice and educational guidance for practitioners expressing interest in research. Medical Education 35(1), 49–55 (2001)
3. Gunkel, M., Schlaegel, C., et al.: Personality and career decisiveness An international empirical comparison of business students' career planning. Personnel Review 39(4), 503–524 (2010)
4. Paglis, L.L., Green, S.G., et al.: Does adviser mentoring add value? A longitudinal study of mentoring and doctoral student outcomes. Research in Higher Education 47(4), 451–476 (2006)
5. Phillips, C.B.: Student portfolios and the hidden curriculum on gender: mapping exclusion. Medical Education 43(9), 847–853 (2009)
6. van Ophuysen, S.: Comparison of diagnostic decisions between novices and experts: The example of school career recommendation. Zeitschrift Fur Entwicklungspsychologie Und Padagogische Psychologie 38(4), 154–161 (2006)
7. Vega, L.E.S., Garcia, L.F., et al.: he Educational and Socio-labour Guidance Program. An instrument to facilitate decision making processes in Secondary Education. Revista De Educacion (351), 73–105 (2010)

Constructing Directed Semantic Relationships between Concepts for Training Semantic Reasoning

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Abstract. With the increasing volume of learning resources on the Web, the need for automatic mechanism for extracting knowledge has become more critical. The aim of this paper is to propose an approach that can automatically construct directed semantic relationships between concepts to help teachers or students efficiently retrieve appropriate knowledge from the Web. The most distinctive characteristic of this approach is its support for constructing with expandable query. This characteristic addresses the problem of users with varying backgrounds. Working with semantically similar expanded terms allows them to filter out irrelevant terms and focus on corresponding contexts. In addition, we design two learning tasks to show that how this the constructed DSR graph can be used to scaffold students' semantic reasoning. The case study suggests relevant benefits of applying semantic technologies in an educational context.

Keywords: Ecological learning, Concept maps, Semantic technology and Simulations.

1 Introduction

The modern ecological education has more emphasis on instructing students about their living environment and subsequently cares about it. For this reason, various researchers have suggested instructional strategies that include presenting students with real-life situations [1, 2]. Such strategies encourage students to acquire ecological concepts from their daily life, and not just from textbooks. Through the use of everyday experiences, learners can acquire new knowledge more efficiently and actively by comparing these experiences with old ones and integrating them [3]. In order to achieve this goal of such strategies, the Web with a lot of learning resources gathered from people's daily experiences is intuitively becoming a useful tool for students to acquire ecological knowledge.

However, if information is input into the Web without proper compulsory and accurate checks before publication, students may encounter difficulties in understanding learning contents by themselves. From the learning strategy perspective, these contents also lack a well-organized structure before they are presented to students. Thus, this study aims to automatically construct systemic relationships between concepts to help novices or experts efficiently retrieve appropriate knowledge from the Web.

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Instead of connecting concepts with taxonomic relationships, the constructed relationships highlighted the importance of linking concepts with non-taxonomic relationships [4], which is an effective ways to encourage reasoning thinking. This kind of non-taxonomic relationships in this paper is called directed semantic relationships (DSR), such as a feeding relationship (see Fig. 1). DSR differs from taxonomic relationships because of the strength of the connection between the two concepts. In other words, the DSR-based graphs offers learners a sequence of deep comprehensible paths through a complex domain of knowledge, as opposed to taxonomic relationship, which often presents simplified relationships, such as parent-child (preceding-following) relationships, between concepts.

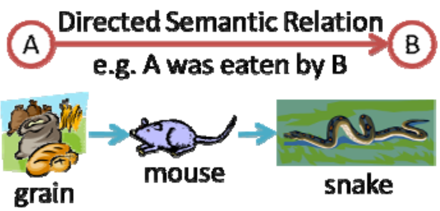

Fig. 1. Food chain examples of directed semantic relationships

To summarize, the purpose of this article is to illustrate an approach that can retrieve the Web information and represent the knowledge with the automatically constructed DSR-based graphs. Hence, an E-learning system can use a DSR to scaffold the learner's semantic reasoning in a complex domain, such as the concept of the dynastic cycle in history, or the water cycle in ecology, energy flow in physics, chemical reaction in Chemistry, and circulatory system in biology.

2 The Proposed Approach

To efficiently and accurately extract DSRs from web documents, this study proposes a framework based on syntactic analysis and semantic techniques (see Fig.2). The most distinctive feature is that the presented approach will expand users' initial query through extracting semantically-similar terms. This way addresses the problem of users with varying backgrounds. Some inexperienced novices may not have enough of prior knowledge to formulate all of the query terms in the system result diagram. Moreover, users may describe similar themes using different terms based on their unique backgrounds. Consequently, a large number of relevant information may not be found by the user's queries.

The core processes of the framework include sentence extraction, concept expansion, action expansion, and semantic role annotation. In the first stage, raw sentences containing query terms are crawled by web search engines. In the second stage, the raw sentences are then parsed using semantic role identification to extract the semantic role of each term in an individual sentence. The surrounding query action arguments are extracted as candidate concepts. The terms that are semantically similar to the query concepts are considered expanded concepts and sent to the next stage. In the third stage, after extracting the semantic roles of the terms in each retrieved sentence, the terms that played the theme role between two concepts are extracted as the candidate actions. The terms that are semantically similar to the query actions are considered expanded actions. In the final stage, through concept and action expansion in the previous stages, the system generated enough concepts and actions to model a complex concept. Hence, a wealth of context-relative sentences can be crawled by web search engines. After extracting the semantic roles of the terms in each sentence using semantic role annotation, the DSRs that contain meaningful structures (who did what to whom) are collected into the database. Finally, the graph is represented by connecting the DSRs, as shown in Fig. 3.

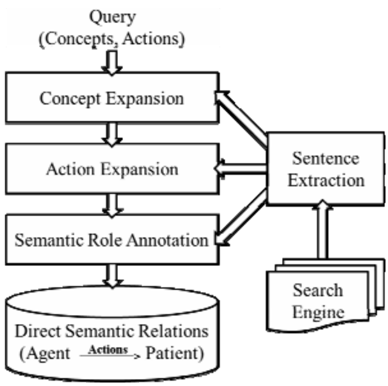

Fig. 2. Overall framework of the directed semantic relation extraction process

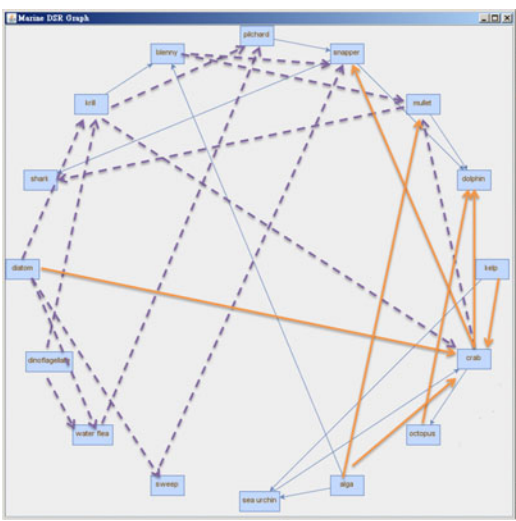

Fig. 3. The results of generated DSR graph for Marine case. Where the light line means correct DSR, the dashed line means incorrect DSR, and the solid line means additional adjusted relation.

3 Implementation in Educational Applications

This study intends to use DSRs to support students' education about the food chain in the computer-supported environments. We designed two successive learning tasks to show how this DSR graph can be used to scaffold students' semantic reasoning in real-life situations.

Before the course begins, teachers can examine students' everyday experiences and design learning situations suitable for engaging them. The proposed DSR extraction approach can support teachers in retrieving relationships from real-life materials automatically. For example, teachers can decide to use the aquarium situation in teaching about the food chain. This method can provide a dynamic advantage over the static method of textbook teaching.

The first task was designed to help students understand simple concepts related to the food chain. Students will be introduced to basic food chain relationships before starting the task. For instance, teachers can explain the definition of the food chain by using the example of a feeding relationship between three living things. After that, students will practice the concept in the first task. This task will show students that the goal that is to construct the connections between different marine lives (see Fig. 4). Students can read the descriptions of marine lives. Students will begin with some initial marine lives. After that, they can drag them into rectangular frames based upon who feed on whom. The system will automatically check the database to confirm whether students' answers are correct or not. If students make a correct answer, this system will reveal one of invisible marine lives as reward.

In the second task, students are presented with real-life problems that require reasoning about complex ecological concepts. This task first shows students that the goal is to set up an aquarium with a limited number of marine lives where every life must be in a balanced circle in order to grow continually (see Fig. 4). Students create their own food webs using the food chain principles learned in the first task. They also need to justify the resources they use and evaluate their preliminary solution by pressing the 'move to tomorrow' button. This task forces students to ask deep scientific questions, such as "What will happen to the blennies when there are a lot of diatoms?" or "How will the aquarium's react of we put oil into it?" To answer these questions students need to link the data to the claim and provide reasons why the

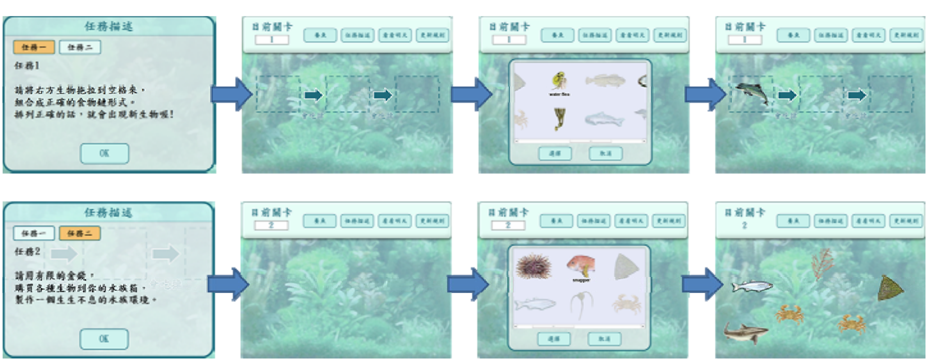

Fig. 4. Steps of tasks for learning food chain concepts that employ DSRs

evidence supports the claims. Decision-making exists in a variety of life situations, and students will be expected to engage in such thought processes. This kind of computer-supported learning environment can also stimulate the transfer of school-based knowledge and skills to real-life contexts.

4 Conclusion

In this paper, we propose an approach that can automatically construct DSRs between learning concepts and form a DSR graph. This system first collects related concepts using a concept expansion process and then expands the actions based on the initial query and expanded concepts. The case study using the DSR graph for scaffolding semantic reasoning suggests that there are benefits to employing semantic technologies in educational contexts.

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References

1. Eilam, B.: Strata of comprehending ecology: Looking through the prism of feeding relations. Sci. Educ. 86, 645–671 (2002)
2. Huang, Y.M., Lin, Y.T., Cheng, S.C.: Effectiveness of a mobile plant learning system in a science curriculum in Taiwanese elementary education. Comput. Educ. 54, 47–58 (2010)
3. Lajoie, S.P., Lavigne, N.C., Guerrera, C., Munsie, S.D.: Constructing knowledge in the context of BioWorld. Instr. Sci. 186, 155–186 (2001)
4. Shamsfard, M., Barforoush, A.A.: Learning ontologies from natural language texts. International Journal of Human-Computer Studies 60, 17–63 (2004)

Live Python-Based Visualization Laboratory

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Abstract. Python is a versatile language that's easy to understand, easy to learn and run on pretty much anything. This article ably demonstrates some of the practical uses of Python and it's packages to build a laboratory for scientific computing with techniques such as graphical user interface, visualization and web-based apps. We also introduce the live platform to the Python computing environment. The live Python platform allows one to boot virtually any recent computer from a single DVD or usb stick into a fully-configured Python laboratory with 1.5G bytes of softwares.

Keywords: Python, visualization, web-based apps, live platform.

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References

1. Hoyles, C., Noss, R.: What can digital technologies take from and bring to research in mathematics education? In: Bishop (ed.) Second International Handbook of Research in Mathematics Eduction, pp. 323–350. Kluwer, Dordrecht (2003)
2. Chang, K.E., Sung, Y.T., Lin, S.F.: Computer-assisted learning for mathematical problem solving. Computers and Education 46, 140–151 (2006)
3. Oliphant, T.E.: Python for Scientific computing. Computing in Science and Engineering (May/June 10-21, 2007)
4. Stein, W., Joyner, D.: SAGE: System for Algebra and Geometry Experimentation. ACM SIGSAM Bulletin 39(2), 61–64 (2005)
5. Eröcal, B., Stein, W.: The Sage Project: Unifying Free Mathematical Software to Create a Viable Alternative to Magma, Maple, Mathematica and Matlab. In: Fukuda, K., van der Hoeven, J., Joswig, M., Takayama, N. (eds.) ICMS 2010. LNCS, vol. 6327, pp. 12–27. Springer, Heidelberg (2010)
6. Langtangen, H.P.: Python Scripting for Computational Science, 3rd edn. Springer, Berlin (1008)

M. Chang et al. (Eds.): Edutainment 2011, LNCS 6872, pp. 407–408, 2011.

7. Huang C.C., Tsai, F.Y.: LiveTeXmacs: A Solution for Higher Level Mathematical Learning system. In: 2nd Conference of Digital Technology, Taiwan, pp. 89–92 (2005)
8. Stein, W.A., et al.: Sage Mathematics Software (Version 4.6.2), The Sage Development Team (2011), http://www.sagemath.org
9. Live Platform, http://diffusion.cgu.edu.tw/ftp

Cage-Based Tree Deformation

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Abstract. Tree models are broadly used in multimedia applications, but it is a challenge task to deform trees with plenty of branches. We propose a novel method to deform the tree model interactively using cages based on trees' property, and we design a framework to control the hierarchy deformation of trees. The bounding box of the trunk is used as the global control cage, while the bounding boxes of branches are set as local cages. The linear combination of mean value coordinates computed from local cages and the global cage decides the vertices deformed positions of the deformed tree. This framework is straightforward and effective, which could also preserve local details of the tree. Experimental results show that our technique is suitable for deforming trees with many branches.

Keywords: deformation, mean value coordinates, tree model.

1 Introduction

Deformation of model is always the hot topic. Since the 1960s, plenty of achievements on research are obtained based on free-form surfaces. The users could deform the complicated models by adjusting the point, the line and the faces of models. This method is popular deformation technique in business software, but it is difficult to hold the geometric detail. Now the cage-based deformation methods on characters are proposed such as MVC (Mean Value Coordinates)-based method [1], [2], HC (harmonic Coordinates)-based method [3], GC (Green Coordinates)-based method [4] and so on. We mainly use the MVC to deform the model of tree. Once the MVC is computed, it is fixed during the whole deformation process. The deformed vertices positions of the tree model are the linear combinations of cage vertices positions, which make sure the computation of deformed models fast.

The plants are popular objects in nature scene, so virtual plant has more and more applications in computer games and 3D films. The number of tree models is limited, but the real trees are in wide range of species and have various shapes. Traditional deformation methods [5] usually do not work for trees. When the tree is deformed as usual, the tree may be split, or the new deformed position can't be computed at all. The deformation based on space is a better choice. However, choosing a suitable

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space to deform is a delicacy problem. Vast space will weaken the agility of deformation for trees as they have more branches than other models. Here we propose a method to deform the models of tree based on cage, and this method could change the shape of models interactively and flexibly, which in turn generate diversity of the shape of tree model in one species.

This paper focus on the deformation of tree models by using cage, in which the cages are the bounding boxes of region of interest and the hierarchy is constructed by skeleton of the tree. We can choose the whole tree model or the branches of tree model to deform. Using our method and current existing tree models, we can generate more tree shapes which can be used navigation of large-scale environment simulation, virtual reality and similar applications. Here the main contribution of our work is listed as follows:

- A novel method to deform the tree model interactively based on cage, and this method could avoid manipulating the vertices of tree model directly.
- A framework to compute the vertices coordinates of deformed tree model, which could hold the detail of tree model.

2 Tree Deformation

In general tree model has two sections: branches and leaves. It is obvious the trunk and branches decide the whole shape of tree. Deforming the branches that we focus on can decide the main contour of the tree.

2.1 Local Deformation

In our interactive system we input the mesh model of tree, and skeleton model of tree which is gotten using [6]. We manipulate the mesh model and the skeleton of tree provides us with hierarchical information. The branches and trunks of trees are nearly cylindrical, and using bounding box as the cage to deform the tree is enough and straightforward. We build the bounding box as cage of the branches (Fig.1 (a)), and we only compute MVC of the vertices in cage. When we adjust the vertices of the cage, the branches in cage are deformed.

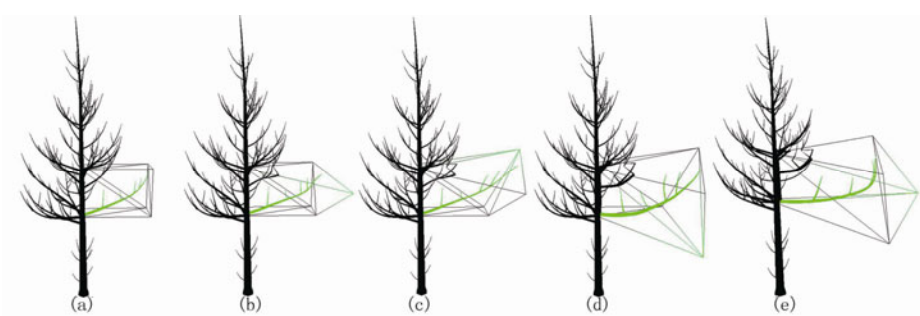

Fig. 1. (a) build the cage of the selected branches, (b)-(e) deform the branches

2.2 Global Deformation

The tree model is made up of trunk and branches, and the contour of the tree is constructed by the trunk and branches. In botany, the trunk makes influence on the whole tree growth, so the deformation of trunk will affect all branches, when we deform the cage of trunk interactively (Fig.2). We compute the MVC based on Ju et al's method [7]. When we adjust the cage, the section of the model outside of cage is also deformed as in Fig.2, which leads to more diversification.

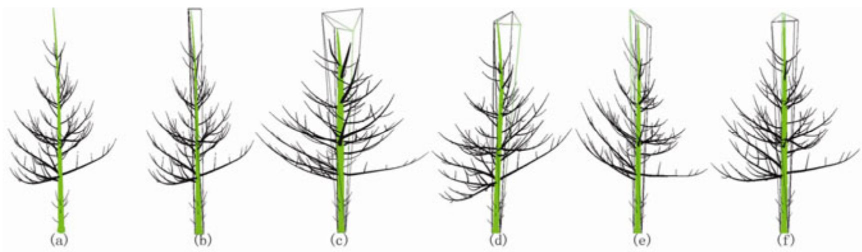

Fig. 2. (a) choose the trunk, (b) build the cage of the selected trunk, (c)-(f) four deformed trees

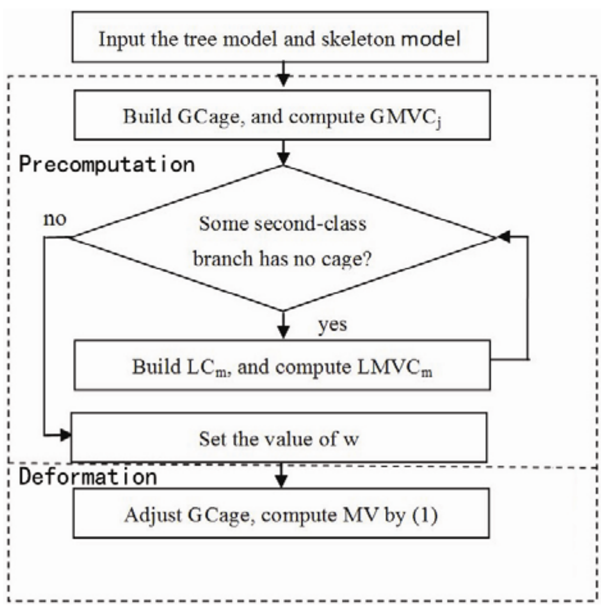

Fig. 3. The pipeline of global deformation

In order to make the branches outside of cage deform under the control, we use the bounding boxes of every second-class branch and its subbranches, which is called local cage (LC_m), and compute MVC according to local cage which is called local MVC ($LMVC_m$). We call the trunk cage global cage (*GCage*) and compute the MVC according to *GCage* which is called global MVC ($GMVC_j$). When we adjust the cage of trunk the coordinate of every vertice of model (*MV*) is computed as follows:

$$MV = w^*(\Sigma\, GCage^*\, GMVC_j)+(1\text{-}w)^*(\Sigma\, LC_m * LMVC_m) \qquad (1)$$

We use the parameter *w* to adjust the weight of local MVC and global MVC which belongs to the interval [0, 1]. Fig.3 shows the pipeline of global deformation. The global deformation of tree model is in two steps:

1. Precomputation. In this step the global MVC and local MVC of model are computed.
2. Deformation. We compute the vertices coordinates of the deformed model by (1).

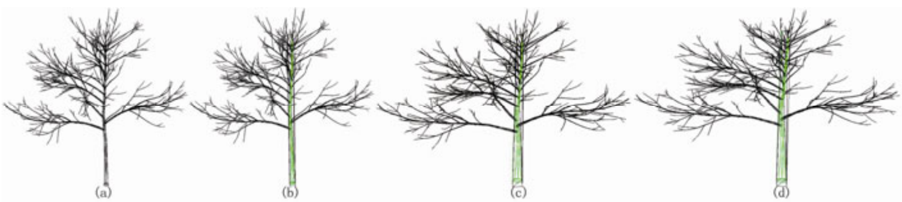

Fig. 4. Apple tree deformation. (a) original tree model, (b) build the cage of the trunk, (c)(d) two deformation, *w*=0.2.

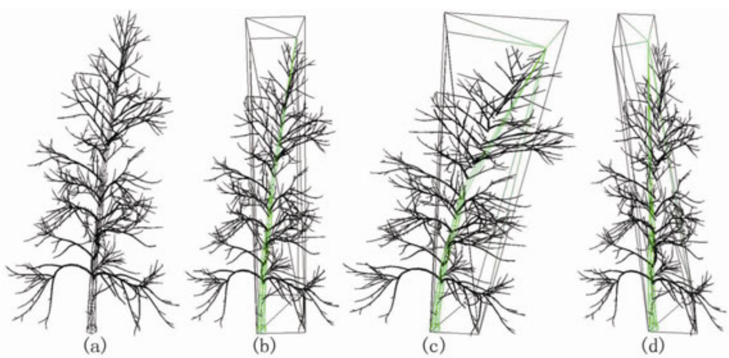

Fig. 5. Birch deformation. (a) original tree model, (b) build the cage of the trunk, (c)(d) two deformations, *w*=0.3.

3 Experiments

We use our framework to deform other tree models and adjust the vertices of the cage almost horizontally. The test is on PC with Intel Core(TM)2 Quad CPU at 2.4GHz and 4G RAM, and our method is written with C language with the support of operation system Windows7. Fig.4 and Fig.5 show the deformation of two trees with no leaf. All the deformation is finished in real time after the precomputation. From the results, we can see that local details of the deformed trees are preserved well.

The parameter w is set to 0.2, 0.3 individually. Compared with other methods of tree deformation such as [8], our method provides less control points to deform the tree model, which is more convenient.

4 Conclusion and Future Work

Tree deformation is a challenge topic because of their abundant branches, which make traditional deformation methods out of action.

In this paper, we propose a cage-based method to deform the tree model, and design a framework which avoids manipulating the vertices of tree model directly and could preserve the local details of tree model perfectly. Experimental results show that our method is straightforward and effective.

Currently the deformation is interactively by controlling the cage manually. In the future we could make the cage move according to the botanic principle of trees to simulating the growing process. We also consider the physical methods to set the cage movement in order to get the animation of windy trees. The collision detection to avoid intersection of branches during the deformation should also be considered and dealt.

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References

1. Floater, M.S.: Mean Value Coordinates. J. Computer Aided Geometric Design 20, 19–27 (2003)
2. Floater, M.S., Kos, G., Reimers, M.: Mean Value Coordinates in 3d. J. Computer Aided Geometric Design 22, 623–631 (2006)
3. Derose, T., Meyer, M.: Harmonic Coordinate. Tech. rep., Pixar Animation Studio (2006)
4. Lipman, Y., Levin, D., Cohen-Or, D.: Green Coordinates. In: SIGGRAPH 2008: ACM SIGGRAPH 2008 papers, pp. 1–10. ACM, New York (2008)
5. Sumner, R., Popvovic, J.: Deformation transfer for triangle meshes. In: Marks, J. (ed.) ACM SIGGRAPH 2004 Papers (SIGGRAPH 2004), pp. 399–405. ACM, New York (2004)
6. Li, H., Zhang, X., Zhang, Y.: Modeling trees with crown shape constraints. In: ACM SIGGRAPH ASIA 2010 Poster (SA 2010), article 38. ACM, New York (2010)
7. Ju, T., Schaefer, S., Warren, J.: Mean Value Coordinates for Closed Triangular Meshes. J. ACM Trans. Graph. 24(3), 561–566 (2005)
8. Habel, R., Kusternig, A., Wimmer, M.: Physically guided animation of tree. Computer Graphics Forum 28, 523–532 (2009)

Stylized Textile Image Pattern Classification Using SIFT Keypoint Histograms

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Abstract. Semantic image classification, which is the process of categorizing images using pattern recognition technology, is very useful for image annotation, organization and retrieval. While the literature has focused on the classification of natural scene photographs or images, here we focus on the stylized textile images and this is totally a new area which is in the domain of artificial images. In this paper, we show that SIFT keypoint histograms perform much better than the traditional gray level co-occurrence matrix with the SVM classifier. Furthermore, we create a low-dimensional representation for each image using principle component analysis (PCA) method to the SIFT keypoint histograms and achieve a better result. To the best of our knowledge, this is the first time the SIFT feature histograms has been used to the classification of stylized textile images.

Keywords: Textile Image, SIFT Keypoint Histogram, Classification.

1 Introduction and Related Works

Flowers, animals, stylized geometric designs and figures are usual recurrent themes in various textile image patterns and stylized textile image pattern possess significance beyond their beauty and often are chosen due to their intense symbolical aspect.

Thus far, the literature of textile image processing has done little work on stylized textile image pattern classification, and What the literature has focused on are textile inspection [1],[2] by the means of image processing and textile image segmentation [3],[4]. Classification using SIFT features and SVM or Adaboost classifiers has various applications nowadays. Di Liu et al. [5] used SIFT feature for face identification using the SVM as the classifier and their experiment finally proved the effectiveness of the proposed scheme. Contrast to outdoor scenes classification, Brian Ayers et al. [6] made an attempt to classify indoor room using SIFT keypoint histograms and achieved the best accuracy by the Adaboost classifier compared with SVM.

In this paper, a SIFT keypoint histograms based effective algorithm for stylized textile image pattern classification is proposed by means of comparison between SIFT keypoint histograms and gray level co-occurrence matrix, as well as the SVM and Adaboost classifiers. After study of the elements distribution of SIFT keypoint histograms in our work, we put out a concept of effective bin which is important to the

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performance of histograms, and finally we use principle component analysis to reduce the dimension of the histograms and get a reasonable result.

The contributions of this paper mainly rely in two aspects: a) Explore the research in the stylized textile image pattern classification and propose a effective algorithm. b) First apply the SIFT keypoint histograms to the textile image analysis.

The rest of this paper is organized as follows: Section 2 and 3 give brief introduction to methods of feature extraction and classifiers and how we use them in our paper. Section 4 presents our experiments and discusses the results. Finally our conclusions and further work are given in section 5.

2 SIFT Keypoint Histograms

We obtain the SIFT keypoint histograms by two steps: SIFT keypoint extraction and Bag-of-Words method.

Scale-invariant feature transform (SIFT) feature is widely used nowadays in the area of computer vision. The first step to extract SIFT keypoints is the detection of keypoints. After the detection of the keypoints, the SIFT descriptors by sampling the magnitudes and orientations of the image gradient in the patch around the keypoints are calculated. In figure 1 there are sample images of two categories in our work with the SIFT descriptors visualized by drawing a circle in the descriptor's position. From the images we can see that the SIFT descriptors mainly locate around the prime structures or textures and according to the differences of prime textures the SIFT descriptors differ in their numbers, distributions, and patterns.

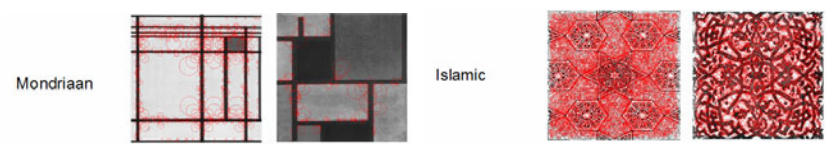


Fig. 1. Images with SFIT descriptors visualized

The visual vocabulary in the Bag-of-Words method is learned from SIFT features of the training image set using an unsupervised clustering algorithm, typically the k-means which is used in our experiment. The cluster centers partition the SIFT descriptor space in a nearest neighbor sense to define the visual vocabulary. Every SIFT keypoint of each image is then mapped to a certain word of the vocabulary according to the partitioning result to create a visual word frequency histogram which is the SIFT keypoint histogram then used in subsequent classification.

3 Classifiers

We experimented with two classifiers: support vector machine (SVM) and Adaboost.

SVM seeks a hyperplane that maximizes the margin between the two classes. To make the data more separable, kernel functions are used to project the data to a higher dimension space. In this paper we use the radial basis function (RBF) kernel. To seek reasonable parameters for the RBF kernel, we use the k-fold cross validation method [7] as the parameter selection scheme. "One against one" method [8] is adopted to make the SVM work for multiclass classification.

Boosting combines many weak classifiers to produce a strong one which often outperforms most strong classifier, such as SVM and Neural Networks. The most popular weak classifiers used in boosting schemes are the decision trees and the simplest of the decision tree is called stump, used by us in this paper, with only a single split node per tree. There are various kinds of boosting which are known as Discrete Adaboost, Real Adaboost, LogitBoost, and Gentle Adaboost [9]. We use the Discrete Adaboost and the Adaboost.MH algorithm [9] for multiclass classification in this paper.

4 Experiments and Results

4.1 Database

The database of stylized textile images can be divided into five categories: African, Australian Aborigines, Islamic, Scandinavian and Mondriaan. In the experiments, we resize all the images to 640*640 and divide each category into parts of train and test. The test set of each category is picked up randomly. Some samples of each category are shown in figure 2.

Fig. 2. Samples of each category

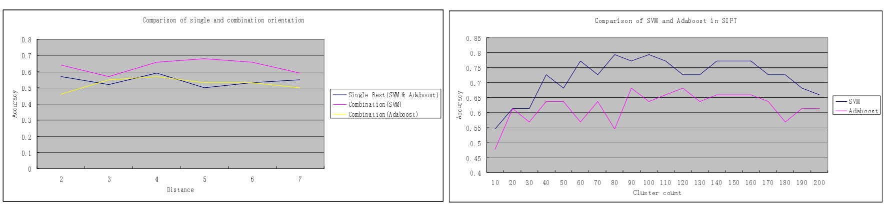
4.2 Comparison between Features and Classifiers

Two sets of experiments were carried out on the database to compare the predicting accuracies of different combinations of features and classifiers. In all the experiments, the two SVM classifier parameters of RBF kernel c and γ were varied in the ranges [-5, 15] and [-15, 3] respectively.

Table 1. Classification accuracy of different orientations and distances

Orient \ Dist	2	3	4	5	6	7
H	SVM 0.5 ADA 0.57	SVM 0.43 ADA 0.48	SVM 0.55 ADA 0.59	SVM 0.43 ADA 0.48	SVM 0.52 ADA 0.52	SVM 0.55 ADA 0.46
RD	SVM 0.52 ADA 0.53	SVM 0.5 ADA 0.41	SVM 0.59 ADA 0.53	SVM 0.45 ADA 0.41	SVM 0.52 ADA 0.52	SVM 0.55 ADA 0.46
V	SVM 0.5 ADA 0.37	SVM 0.48 ADA 0.48	SVM 0.53 ADA 0.55	SVM 0.47 ADA 0.41	SVM 0.53 ADA 0.5	SVM 0.55 ADA 0.48
LD	SVM 0.48 ADA 0.47	SVM 0.52 ADA 0.5	SVM 0.55 ADA 0.53	SVM 0.5 ADA 0.43	SVM 0.43 ADA 0.5	SVM 0.5 ADA 0.52

The first set of experiments was aimed at finding the best orientation and distance used to construct the co-occurrence matrix which will have a better impact on the prediction performance. As is shown in the table 1, the variation of orientation doesn't mean much to the accuracy performance while the pixel distance of 4 performs more stable and mostly better and the performances of SVM and Adaboost are more or less the same. Here we make a further study, we combined features of four orientations separated by the same distance to construct a new feature vector as the input to the classifiers and the result comparing its accuracy with the best in table 1 is shown in figure 3 (a). From the figure we can see that the combined feature classified by SVM performs better.



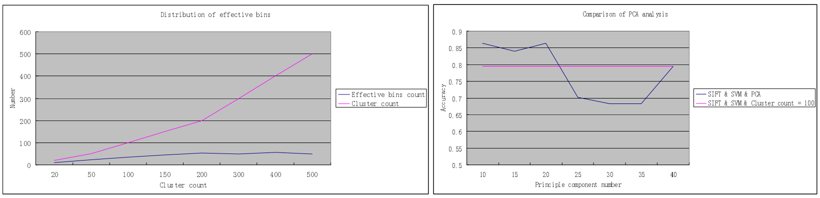
(a) (b)

Fig. 3. (a) Comparison between single and combined orientation features. (b) Comparison between SVM and Adaboost in SIFT.

The other set of experiments was carried out to investigate the influence of size of vocabulary on the accuracy performance with different classifiers. In this paper, we considered the sizes from 10 to 200 with the step of 10 and the experiment results were in figure 3 (b). One obvious thing that we can see from this figure is that the accuracies obtained by SVM is better than Adaboost. Another observation we can make is that the accuracy achieves the highest in the size domain of [80,100]. We will make a further study on the later observation in part 4.3. We can conclude that the SIFT keypoint histograms with classifier SVM is the best of all and the best performance of it reaches 79.8%.

4.3 Reduce the Size of Vocabulary Using PCA

In this part, we study the contents of the histograms and the result is shown in figure 4 (a). The effective bin refers to the bin whose word number is not zero after the process of word assignment. We can learn from the figure that with the growth of vocabulary size the number of effective bins increases slowly and is relatively high when the vocabulary size is 100 and the ratios of effective bins to vocabulary size are decrease. That may explain why the accuracy achieves the highest in the size domain of [80,100] if the accuracy depends both on the size of effective bins and the ratio of effective bins count to vocabulary size.



(a) (b)

Fig. 4. (a) Distribution of effective bins. (b) Comparison of PCA analysis

We make another set of experiments which reduce the size of the vocabulary using principle component analysis (PCA) method and here we only show the case of histogram size 100 which is persuasive. The result is in figure 4 (b). We can conclude from the figure that the performance with small principle component number of PCA, here is smaller than 20, is better than that with the original histogram size and in this experiments the best performance is 86.8%. The result is inspiring because we can get a high accuracy with a small size of histograms and this will make the classification task of textile images more effective.

5 Conclusions and Further Work

In this paper, we have shown that SIFT feature histograms work pretty well in the stylized textile image pattern classification. Although SIFT histograms have been used in a variety of areas, there have been no prior studies on the stylized textile image pattern classification. In our work, SIFT feature histograms with the SVM classifier shows significant performance in the stylized textile image pattern classification and can be more efficient using the PCA method.

Further work can be divided into two parts. Firstly as shown in the experiment results above, the stump based Adaboost classifier didn't work well in this work, so a larger database of images and new weak classifiers are needed to further examine the performance of the Adaboost method. The other is that the number of the effective bins is not large enough using the k-means clustering method, so a more powerful clustering method should be tried which may result in a better accuracy.

References

1. Donciu, C., Temneanu, M.: Integrated Visual-Smart Inspection System for the Textile Fabrics developed by Image Virtual Processing Methods. Industria Textila 60(3), 134–145 (2009)
2. Gowayed, Y., Schreibman, D.V., Roberts, M.: Surface Inspection of Textile Composite Materials using Image Analysis Techniques. Journal of Composites Technology & Research 18(1), 3–14 (1996)
3. Bao, X.-M., Peng, X., Wang, Y.-M., et al.: Textile Image Segmentation Based On Semi-superviced Clustering and Bayes Decision. International Conference on Artificial Intelligence and Computational Intelligence 3, 559–562 (2009)
4. Li, P.-F., Wang, S.-R., Jing, J.-F.: The Segmentation in Textile Printing Image Based on Mean Shift. In: International Conference on Compuer-Aided Industrial Design and Conceptual Design, pp. 1528–1532 (2009)
5. Liu, D., Sun, D.-M., Qiu, Z.-D.: Bag-of-Words Vector Quantization Based Face Identificaion. In: Proceedings of the Second International Symposium on Electronic Commerce and Security, vol. 2, pp. 29–33 (2009)
6. Ayers, B., Boutell, M.: Home Interior Classification using SIFT Keypoint Histograms. In: Conf. on Comp. Vis. And Pat. Rec., vol. 1-8, pp. 3628–3633 (2007)
7. Vapnik, V.: The Nature of Statistical Learning Theory. Springer, New York (1995)
8. Pontil, M., Verri, A.: Support Vector Machines for 3-d Object Recognition. Patter Anal. Machine Intell. 20 (1998)
9. Friedman, J. H., Hastie, T., Tibshirani, R.: Additive Logistic Regression: a Statistical View of Boosting. Technical Report, Dept. of Statistics, Stanford University (1998)

The Attributes and Importance of Online Game with Language Learning for College English-Majored Students

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Abstract. This study was aimed to explore college English-majored students' perceptions toward game-based learning and their current needs and expectation of interesting online games. Questionnaire survey and in-depth interview were used as the research method. Descriptive analysis and independent t-test were employed to analyze the collected data. The findings of this study show that a new, interesting, and challenging game with multimedia effects would be more appealing and attractive to them to play. Simple, easy-to-operate, and user-friendly are the most important characteristics of an interface for consideration when playing an online game. Additionally, playing online games can help the students relax and relieve pressure, improve their concentration as well as enhance their creativity. Furthermore, the students may enhance their English vocabulary, pronunciation, expression ability through game playing. Finally, female students prefer an online game with screen captions and live and practical English dialogue practices, and male students consider that playing online games makes them get insufficient sleep and causes poor health.

Keywords: English-majored student, game-based learning, online game.

1 Introduction

In the past years, due to the rapid growth and development of the information technology (IT) industry and Internet, online games have been growing in popularity and are receiving an increasing amount of attention (Chang, et al., 2011). Online games are popular with the "net generation". According to Leung (2004), the net generation is the first generation to grow up surrounded by home computers, video games, and the Internet. With the popularity of personal computers, the population of online game players is increasing. Online games are mainly profit-oriented in the market, but recently, many studies combining entertainment and education are being done by scholars and researchers. According to Chung & Tseng (2010), the United States and Korea are paying more attention and applying more effort to game-based learning recently. Additionally, the goal of game-based learning is to get people to learn certain subjects or acquire knowledge and skills by means of playing. Game players can develop problem-solving skills, overcome challenges, and complete tasks and missions through game playing (Yang & Chen, 2010). Thus, educational games must fulfill both recreational and educational goals. How to develop games, online games

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in particular, with educational purposes has become an important challenge for game designers, developers, and educators. Therefore, the goals of this study were to explore college students' perceptions toward game-based learning and language learning and to investigate their current game-playing experiences and needs.

2 Literature Review

The advent of new technologies is rapidly transforming and affecting the content, approach, and place of peoples' learning. In recent years, online gaming has become a new trend and form of entertainment, leisure activity, and source of socialization for many people, particularly for youngsters (Chen et al., 2010). Digital game-based learning is the next generation's educational media, which focuses on multiple forms of interaction with learners, learning content, and instructors. Some studies were concerned about game players' flow experience and features of flow states in relation to player's behavior, performance, or interaction (Chang et al., 2011). Additionally, some researchers also claimed that game content could arouse various affective responses or negative emotions (Anderson, 2004; Chang et al, 2011). Furthermore, researchers also debate whether online games have negative impact (e.g. online game addiction) on players or not (Griffiths & Davies, 2005; Chumbley & Griffiths, 2007). Past studies examining the attributes, motivational traits, and learning effects of games have been extensively presented in the literature (Amory, 2010). However, the topics of system design and implementation, especially for online games have not been sufficiently investigated.

Regarding the attributes of online games, Yee (2006) presented five factors of user motivations, including achievement, relationship, immersion, escapism, and manipulation. These illustrate the multifaceted appeal of online environments. Additionally, Williams (2006) stated that online games may improve learners' global outlook and sense of online community. Online games also provide fun and intellectually challenging entertainment. Moreno-Ger et al. (2008) also pointed out pedagogical approaches of game design such as real-time adaptation to fit learner needs, in-game assessment and grading, and the integration with online education environments. Holsapple and Wu (2008) also examined the proposition that, "players' knowledge about website characteristics (i.e., security and interface design) and about website outputs (i.e., online game quality and service quality) has an effect on the development of trust in the context of online game websites (p. 47)." Dickey (2006) pointed out two primary elements in massively multiple online role-playing games (MMORPGs) design, the character design and the narrative environment. However, there are insufficient studies concerning the relationship between the attributes or characteristics of online games and English as a second language (ESL) learning, particularly for students majoring in ESL/EFL.

3 Research Method

Questionnaire survey and in-depth interview were used as the research methods of the study. The research instrument was a self-developed survey questionnaire containing five domains, four multiple choice questions, and 37 five-point Likert scale questions. The questionnaire was validated prior to the pilot study. The content validity and reliability of the survey questionnaire were established through a series of statistical analyses. The questionnaires obtained a 0.926 Cronbach Alpha coefficient of reliability, reflecting a very high level of internal consistency in the questionnaire. The formal questionnaires were sent to 150 college students in a technological university in southern Taiwan with a total of 136 valid responses were returned giving a 90% return rate. The responses of the survey questionnaires were analyzed by independent t test and descriptive SPSS analysis. In addition, in-depth interviews were conducted to obtain more detailed information about the use of online games and language learning.

4 Findings and Discussions

According to the survey, the most commonly played online games by the English-major students are: World of Warcraft, Lineage, and Maple Story respectively. Figure 1 shows an example webpage of World of Warcraft.

Fig. 1. An example webpage of World of Warcraft

Regarding the frequencies of responses to the Domain I multiple choices questions: What attributes in a game do you like most or can inspire you to use most? The top five attributes that the students like most or can inspire them to use the online game are: the game must be interesting and challenging (13%), the game must be new and attractive (10.2%), the game must have the interaction function (9.7%), the game must have socializing function (8.6%), and the game must have plentiful multimedia effects (8.2%) on a basis of 134 valid responses. Regarding the frequencies of responses to the Domain II multiple choice question: what attributes of the interface in a game attract you to play? The top three responses with the highest frequencies are the interface must be easy-to-use (22.8%), the interface must be simple (21.7%), and the operation of the interface must be user-friendly (14.1%). In terms of frequencies of responses to the Domain III multiple choice question: With what aspects of English learning can a game assist you? The top five frequently answered responses are learning English through game playing (13.9%), learning live and practical English dialogues through online games (n=76, 13.8%), screen captions can assist in learning vocabulary (13.8%), online games can assist in improving expression, pronunciation, and comprehension abilities (6.9%; 6.7%; 6.7 % respectively). In terms of frequencies of response to Domain IV multiple choice question: What kinds of influences would an online game have on you? In this domain, the results of responses show that English-majored students agreed that the most influential factors in an online game include: online games help them relax and relieve pressure (27.8%), help them train their concentration (14.9%), and inspire their creativity (14%).

The 37 questions regarding the importance of online games in the survey questionnaire obtained mean scores ranging from 2.2868 to 4.3309. Question 7 and Question 8 obtained mean scores of 2.2868 and 2.8750 respectively, indicating that most of the students think it is not important for an online game to have plug-ins and most of the students did not agree that a copy-making function is important to an online game for them. On the contrary, Questions 18, 19, and 13 obtained the highest mean scores of 4.2721, 4.3309, and 4.2500 respectively, indicating a simple and easy-to-read interface is also very important to them; an easy-to-operate interface is considered the most important attribute in an online game for them; and an online game with account-protection function is also important for them when choosing an online game to play. The statistical results show that the male and female students possess different points of view on the Domain IV answer 8 "Playing an online game makes me not get enough sleep and causes poor health" indicating that there is significant difference between male and female's perception. Male students (M=3.2500) think playing online games make them not get enough sleep and causes poor health; female students to a lesser extent (M=2.6957). Additionally, the male and female students have a significant difference in their perception on Question 18 "The interface of an online game should be simple- and easy-to-read", indicating the female students (M=4.439) think a simple- and easy-to-read interface is more important for them than the male students do (M=3.9545). Question 25 "Online games should contain live and practical English dialogue practices" shows a significant difference between male and female students, indicating the female students (M=4.1630) think live and practical English dialogue practice in an online game is more important for them than the male students do (M=3.7045). Finally, the male and female students show a significantly different perception toward Question 26 "Screen captions for assisting in learning vocabulary in an online game", indicating the female students (M=4.1087) think having screen captions for assisting in learning vocabulary in an online game is more important the male students do (M=3.6818).

5 Conclusion and Suggestions

The results of this study indicate that a new, interesting, and challenging game with multimedia effects would be more appealing and attractive to them to play. Simple, easy-to-operate, and user-friendly are the most important factors of consideration when playing an online game for the students. Students also suggested that the most desirable advantages for learning English from game playing include: learning live and practical English dialogue or conversation from playing an online game, learning vocabulary from the captions of the online game, improving comprehension and expression abilities, and improving English pronunciation. Online game playing can also influence students by helping them to relax and relieve pressure, improving their concentration, and enhancing their creativity. Furthermore, female students are more diligent than the male students. Finally, female students tend to be more self-disciplined and good at time management than male students. The results may provide useful messages to game-producers and language instructors as references in improving the content of online games and language instruction. Future research can conduct more in-depth analyses in this regard or other areas concerning the students' social network and psychological influence when playing an online game with language learning. Finally, this study was limited to a group of college English-majored students only. Similar studies may be implemented with more subjects and schools.

References

1. Amory, A.: Learning to play games or playing games to learn? A health education case study with Soweto teenagers. Australasian J. Educational Technology 26(6), 810–829 (2010)
2. Anderson, C.A.: An update on the effects of playing violent video games. J. Adolescence 27(1), 113–122 (2004)
3. Chang, Y.T., Lin, S.S.J., Cheng, C.Y., Liu, E.Z.F.: Exploring online game players' flow experiences and positive affect. The Turkish Online J. Educational Technology 10(1), 106–114 (2011)
4. Chen, L., Chen, T.L., Liu, H.K.J.: Perception of young adults on online games: Implications for higher education. The Turkish Online J. Educational Technology 9(3), 76–84 (2010)
5. Chumbley, J., Griffiths: Affect and the online game player. The effect of gender, personality, and game reinforcement structure on affective responses to online game-play. Cyberpsychology & Behavior 9(3), 308–316 (2007)
6. Chung, Z.Z., Tseng, L.Y.: Exploring the learning effect of characters' moving speed on Jie-Jie-Le learning game. In: Proceeding of International Conference of Web 2.0 and Education, ICWE 2010, Taiwan, pp. 276–279 (2010)
7. Dickey, M.: Game design and learning: a conjectural analysis of how massively multiple online role-playing games (MMORPGs) foster intrinsic motivation. Educational Technology Research and Development 55(3), 253–273 (2006)
8. Griffiths, M.D., Davies, M.N.O.: Videogame addiction: Does it exist? In: Goldstein, J., Raessens, J. (eds.) Handbook of Computer Game Studies, pp. 359–368. MIT Press, Boston (2005)
9. Holsapple, C.W., Wu, J.: Building effective online game websites with knowledge-based trust. Information Systems Frontiers 10(1), 47–60 (2008)
10. Moreno-Ger, M.P., Burgos, D., Martinez-Ortiz, I., Sierra, J.L., Fernandez-Manjon, B.: Educational game design for online education. Computers in Human Behavior 24(6), 2530–2540 (2008)
11. Williams, D.: Groups and Goblins: The Social and Civic Impact of an Online Game. J. Broadcasting & Electronic Media 50(4), 651–670 (2006)
12. Yee, N.: The Demographics, Motivations, and Derived Experiences of Users of Massively Multi-User Online Graphical Environments. Presence: Teleoperators and Virtual Environments 15(3), 309–329 (2006)

The Influence of the Presentations of Game-Based Learning Teaching Materials on Chinese Idiom Learning

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Abstract. This study aims to probe into influence of presentation of game-based learning teaching materials on junior high school students' Chinese idiom learning. It adopts quasi-experiment and treats 105 eighth grade students of one junior high school of Pingtung County in Taiwan as subjects. Research tools are self-designed pre-test of Chinese idiom learning effectiveness, after-learning, procrastinating and learning feedback questionnaire. Descriptive statistics, test of homogeneity, one-way ANOVA and covariance analysis are conducted by SPSS14.0. Conclusions are: (1) presentations of game-based learning teaching materials reveal significant difference on Chinese idiom learning effectiveness; (2) students have positive Chinese idiom learning feedback regarding presentation of game-based learning teaching materials. Finally, the researcher indicates the suggestions as criteria for future implementation of game-based learning and Chinese idiom instruction.

Keywords: game-based learning, multimedia, Chinese idiom learning, junior high school.

1 Research Motives and Purposes

In the 21st century with advancement in high-technology information, along with the prevalence of computers, multimedia including text, image, animation and sound effects (audio and video) immediately becomes popular. Instruction in schools changes significantly because of the advancement of computer technology and internet. Thus, "multimedia" is one of the measures considered by teachers for new instruction. Among others, game-based learning can skillfully combine visual and audio effect of multimedia and create an interesting virtual learning environment. By games, it triggers learners' learning motive and interests and easily transfers knowledge or skill learning. Many empirical studies demonstrate that game-based learning can enhance students' learning effectiveness, memory, growth of knowledge and active attitude (Florence & Alvin, 2006). Chinese idiom teaching is an important part of Chinese instruction. Growth and accumulation of idioms knowledge will increase the competence and application of Chinese listening, speaking, reading and writing. However, observation in instructional site shows that in traditional environment, students usually cannot comprehend and apply knowledge. Therefore, instructional

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strategy of digital game-based learning and idiom instruction should be a feasible issue worthy of further study. Based on the research motives above, this study aimed to probe into difference of various presentations of game-based learning teaching materials on Chinese idiom learning effectiveness and to probe into influence of presentation of game-based learning teaching materials on idiom learning feedback.

2 Literature Review

1. Multimedia instruction and game-based learning

Many studies have combined multimedia instruction and games into "digital game-based learning" to incorporate games with education. By text, sound effects, image, animation, interface, playing and stories, it constructs digital games. Ideas of game-based learning are below: 1) design stories and skills according to learning objectives; 2) specific rules and attractive learning situations; 3) according to learning content, it decides the simplification process of game simulation Therefore, when instructors plan game-based learning activities or teaching materials, they should recognize the goals, content of instructional activities and learners' backgrounds to further establish teaching materials and activities. They should also rely on proper instructional design and concept to fulfill complete instructional effect (You, Hsiao & Han, 2004). Many researches demonstrate that game-based learning in education reveals positive influence and advantage. It can lead to learners' learning motive, increase positive learning effectiveness, offer practice and feedback mechanism and extend the memory (Lin, 2008; Huang & Tsui, 2010; Florence & Alvin, 2006). It can result in positive learning effect even for abstract instruction such as chemistry or civil engineering (Weng & Chuang, 2008; Ebner & Holzinger, 2007). By specific game design, instructors' concepts and ideas are simplified and learning becomes easy.

Chinese idioms are accumulation and demonstration of Chinese culture and wisdom. In society with Chinese as mother tongue, they are the necessary factors for effective communication. Idiom instruction not only aims to increase students' learning of Chinese culture, but also enhances students' learning interest and reading, expression and writing competences. In addition, idioms include profound implication and philosophy and they can cultivate students' characters and behavior (Cheng, 2005). Therefore, this study combines computer-based instruction and game-based learning and applies game-based learning teaching materials to Chinese idioms instruction to explore junior high school students' idiom learning effectiveness in order to recognize the influences of different presentations of teaching materials.

3 Research Design and Implementation

1. Research Method

This study adopted quasi-experiment in order to probe into different idiom learning effectiveness of junior high school eighth grade students who received different types of presentation of game-based learning teaching materials. In addition, after idiom learning, questionnaire survey was conducted on students in order to understand their learning reaction when receiving different presentations of game-based learning teaching materials. This study adopted rotation experiment in quasi-experiment.

2. Research subjects and grouping
Eighth grade students in three classes of one junior high school were treated as experimental subjects. There were three groups. In the experiment, independent variables are presentations of game-based learning teaching materials and dependent variables are learners' learning effectiveness and learning feedback. Teaching materials presentations refer to text, narration and combination groups. Each group randomly includes 35 participants.

3. Research tools
(1) Selection and design of teaching materials
Origins, stories, and meanings of the six idioms are presented by different multimedia. Text group was based on the presentation of 2D animation and captions, played by Flash Player; narration group was based on the presentation of 2D animation and sound effects, played by Flash Player; combination group was upon the presentation of 2D animation, sound effects and captions, played by Flash Player. A display of the presentation is shown in Figure 1.

Fig. 1. Display of text group

(2) Design of tests and questionnaire
Idiom tests in this study included pre-test, after-learning test, and procrastinating test. Reliability and validity of tests were constructed by expert content. The content included "memory, comprehension, transfer and total learning". The Likert 5-point questionnaire was divided into two sections: students' basic information and items. As to reliability of questionnaire, the Cronbachα is greater than .94, indicating that the learning feedback questionnaire is reliable and there is internal consistency.

4 Results and Discussion

1. Pre-test and post-test analysis of presentations of game-based learning teaching materials on Chinese idiom learning. Regarding students' learning effectiveness

tests of presentations of (text group, narration group and combination group) of game-based learning teaching materials, mean of post-test is higher than pre-test. The result of covariance analysis test demonstrates that after receiving three presentations of game-based learning teaching materials, students' memory, comprehension and total learning in idiom learning effectiveness are significantly influenced and there is statistically significant difference. On the other hand, "transfer" (F=.94, p>.05) is not significant. That is, students' transfer learning in idiom learning effectiveness test is not significantly influenced.

2. Analysis of presentations of game-based learning teaching materials on Chinese idiom after-learning and procrastinating. The results show different presentations of game-based learning teaching materials meet the assumption of variance homogeneity. Additionally, the results demonstrate that different presentations of game-based learning teaching materials reveal significant difference on "procrastinating post-test comprehension difference" (F=4.59, p=.011<.05). According to post hoc comparison, memory gap of narration group "procrastinating post-test comprehension difference" is significantly less than combination group.
3. Analysis on students' feedback to multimedia presentation of Chinese idiom learning. The results show that students are positive toward receiving different presentations of game-based learning teaching materials and they have learning intention. Generally speaking, most of students agree and identify with different presentations of game-based learning teaching materials. As to statistical result of multiple choices of questionnaire "My favorite in this idiom instruction", 35.5% students enjoy watching idiom story animation, including text, narration or combination group; 19.5% students enjoy watching idiom story animation and they only watch combination group; 15.2% students enjoy the related questions of idiom stories; 11.7% students prefer watching idiom story animation and they only watch text group; 9.1% students prefer watching idiom animation and they only watch narration group; 9.1% students prefer making sentences by idioms.

5 Conclusion and Suggestions

Different presentations of game-based learning teaching materials reveal significant difference on idiom learning effectiveness. Students' idiom learning effectiveness is significant. Therefore, students make significant progress in learning effectiveness. However, transfer in students' idiom learning effectiveness test is not significantly influenced. As to students' after-learning, procrastinating learning situation and difference, mean of total learning effectiveness difference in narration group is the least; the second is text group, and the last is combination group. Mean of learning effectiveness difference of transfer in combination group is lower than narration group and text group. The results also show that memory gap of narration group regarding idiom comprehension is significantly less than combination group. Students are positive toward different presentations of game-based learning teaching materials and they have learning intention. However, as to "use difficulty of going too far is as bad as not far enough and Racking one's brain", students suggest that they have difficulty applying idioms. Thus, they do not identify with it. The reason can be in that students are unfamiliar with these two idioms. Generally speaking, most of students agree and are positive toward idiom instruction with different presentations of game-based learning teaching materials.

It is suggested that teachers should properly modify the courses and use game-based learning teaching materials instead of focusing on blackboard writing and rigid instruction and restricting students' learning space and development of multi-intellectual capabilities. Therefore, it is important for teachers to enhance multimedia use and planning of interesting and multiple instructions. According to after-learning test and procrastinating outcome, in the future, based on different instructional purposes and short-term and immediate effectiveness, when using game-based learning teaching materials, instructors can train students' memory by combination methods, such as pronunciation and shape of characters. On the contrary, for long-term effect, when using game-based learning teaching materials, instructors can train students' concentration and listening ability by narration. The students' learning will be more effective in long term and they will comprehend and apply the knowledge. Article writing can be the measure. Finally, future researchers can consider increasing number of experimental participants and subjects from different levels and experimental time as well as to enhance preciseness of random sampling experiment.

References

1. Ebner, M., Holzinger, A.: Successful Implementation of User-centered Game Based Learning in Higher Education: An Example from Civil Engineering. Computers & Education 49, 873–890 (2007)
2. Florence, W.M.Y., Alvin, C.M.K.: Online Vocabulary Games as a Tool for Teaching and Learning English Vocabulary. Educational Media International 43(3), 233–249 (2006)
3. Huang, Y.T., Tsuei, M.P.: The Influence Which Digital Game Types Have on the Chinese Phonetic Symbol Learning Effects. In: The E-Learning and Information Technology Symposium 2010, Tainan, Taiwan (2010)
4. Jheng, P.S.: Study on the Syntax and the Pedagogy of Chinese Idioms. Unpublished master's thesis, National Sun Yat-Sen University, Kaohsiung, Taiwan (2005)
5. Lin, T.Y.: Podcasting, Blog, Mobile Learning and Game-based Learning: Four Digital Learning Models on Chinese E-learning Web-site. Chung Yuan J. of Teaching Chinese as a Second Language 2, 135–154 (2008)
6. Own, Z.Y., Chuang, K.H.: The Study Applied with a Digital Game-based Learning in the "Material Change" Unit. The Living Technology Education 41(6), 82–103 (2008)
7. Wang, Y.F.: An Analysis of the Idioms Used in the Authorized Versions of Native Languages in Elementary Schools. Unpublished master's thesis, National Hsinchu University of Education, Hsinchu, Taiwan (2004)
8. Yu, K.C., Hsiao, H.S., Han, F.N.: Design of an Online Game-based Learning System. Taiwan J. of Arts 75, 205–217 (2004)

Study on Influence of Adventure Game on English Reading Confidence, Motive and Self-efficacy

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Abstract. The purpose of this study was to explore the relationship of adventure game playing and English learners' reading confidence, motivation, and self efficiency. Forty-five non-English major students in a technology university were surveyed. Comparisons of reading confidence, motivation, and self efficiency between high and low achievement learners were made. The use of adventure games can improve the capability of reading teaching. The results shows that: (1) adventure games can improve the students' learning motivation of reading; (2) adventure games can improve readers' English reading confidence, especially for male students; (3) adventure games can improve students' English reading self efficacy.

Keywords: Adventure Game, English reading Confidence, English reading motive, English reading self-efficacy.

1 Introduction

It is necessary and critical to learn English. In English learning, anxiety results in negative influence. Horwitz et al. (1986) claimed that foreign language anxiety is a unique type of anxiety specific to foreign language learning. Many studies have also focused on anxiety with respect to classroom activities such as speaking and listening, suggesting that oral classroom activities are most problematic and anxiety-provoking for foreign language learners (Steinberg and Horwitz, 1986; MacIntyre and Gardner, 1994; Mejı´as et al., 1991). However, there is little research on the influence of English learning anxiety on English reading.

The Strategies for the instruction of English reading is very important. For instance, Hidi and Anderson (1986) applied extracts and short introductions to help learners comprehend reading materials. Goodman (1989) adopted an inferring strategy which helped good readers. Taiwanese scholar Chi (1997) applied elaborating (enhancement strategy) to effectively enhance readers' comprehension of reading materials. Poor readers tended to be lost in paragraphs and could not organize the fragmental comprehension. O'Mally and Chamot (1990) indicated that reading

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strategy connected language and background knowledge. Moreover, some scholars suggest that confidence and motive lead to English learning anxiety which influences English learning. English learning anxiety based upon confidence would influence foreign language learners' reading performance. This study will try to find how to increase poor readers' English competence. How can gaming be combined with English reading learning to increase poor readers' English reading competence? What kinds of games can meet players' reasons (”challenge" and "euphoria") to enjoy games? And the game's content should meet the structure and context of English reading materials. Moreover, learners need make efforts to pass the challenges in the game which stops their learning. There is no time limit for overcoming the challenges. In addition, the game is not long and it can meet the demand of mild players. Adventure Games aim to "unriddle the game". Players only unthread the puzzles according to the situations of the game and they cannot spend time fighting and arranging. They finish the game by successfully unthreading the puzzles. In addition, Adventure Games reveal characteristics of challenge and the situations are based on structure and context of story telling. They meet the descriptions of Carris, Ahlers and Driskell (2002) regarding digital game-based learning.

Therefore, this study used 45 technical university students in non-English departments as subjects and by quasi-experiment, probe into the influence of an Adventure Game on English learners' reading confidence, motive, and self-efficacy. Comparisons of reading confidence, motive and self-efficacy between high and low-achievement learners and genders are made to investigate the feasibility of using Adventure Games to improve reading instruction.

2 Method

This study is based on quasi-experiment. Research time is 3 hours. There were three stages and each stage lasted for 50 minutes. Before and after the study, participants filled in the questionnaires. This study adopts the Adventure Game "Alice is Dead" developed by Newgrounds (http://newgrounds.com). The game is based on the story Alice in Wonderland. There are three increasing degrees of difficulty. The game guides the players to "unriddle" the game with clues from the text. The text of the game includes two sections: texts of situation and interaction. Players must play the game after reading the situation text. In the game, there is text of interaction to allow the players to modify and play the game.

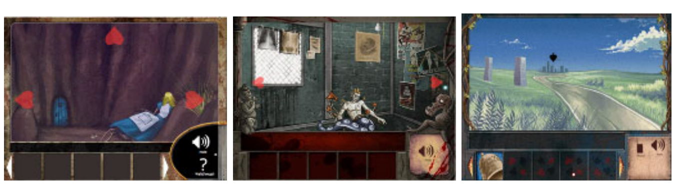

Fig. 1. Version: Alice is Dead

The questionnaire included three dimensions: “English reading motive”, “English reading confidence” and “self-efficacy of English reading”.

3 Result

The test of learning motive of this study aims to find if learners’ learning motive is different after participating in Adventure Game English reading. The statistical results of the English reading motives were significantly different ($p<0.05$). Thus, after the study, all learners’ English reading motives are higher than those before the study. It demonstrates that Adventure Games are significantly effective for improving learners’ English reading motive. According to classroom observation records and focused interview results, the researcher realizes that learners are highly interested in English reading learning through Adventure Games. Challenging, fun and entertaining are the images of game-based learning for learners. However, since Adventure Games are different from ordinary RPGs, learners must fully understand the situation and clues, and carefully pass the challenge according to the text of clues. Since difficulty degrees of “Alice is Dead” increase from 1 to 3, learners’ motive on applying the adventure game to English reading learning gradually decreases. However, generally speaking, they still have a high degree of learning motive regarding game-based learning.

The test of reading confidence in the experiment aims to find if learners’ reading confidence is different after participating in Adventure Game English reading. The statistical results of the English reading confidence test. Participants with low-achievement English reading had significantly different confidence before and after study ($p<0.05$). The finding demonstrates that Adventure Game English reading is significantly effective in improving low-achievement learners’ reading confidence. Among low-achievement learners, there was a significant difference in reading confidence among males before and after the test ($p<0.05$). However, there were no other significant differences in reading confidence regarding gender. Based on classroom observation records and focus interview results, the researcher realizes that learners are confident in text reading during the game; however, they are unconfident in passing all the challenges. Malone and Lepper (1987) suggested that the educational game should be designed upon appropriate difficulty and an easy-to-learn environment. Difficulty of games can be a challenge for learners. Although challenge is a key to a successful game (Pagulayan, et al 2003), it should not influence learning. However, for low-achievement male students, since in their daily lives, they encounter challenges in games, regarding game use and logic, they are more able to deal with the game and frustration. Thus, they highly agree that they can play the game as well as learn English.

The test of reading self-efficacy aimed to find if learners’ reading self-efficacy is different after participating in the experiment involving an Adventure Game with English reading. The results of the t-values of English reading self-efficacy for the test groups, high achievement, low achievement, females, high achievement females, and low achievement females indicated significant differences ($p<0.05$). This demonstrates that Adventure Games with English reading are significantly effective in improving the reading self-efficacy of female learners. However, t-values for males, high-achievement males, and low-achievement male learners’ English reading self-efficacy before and after the study did not reach the established significance level

(0.05). In other words, male learners with either high or low-achievement do not demonstrate significant differences in reading self-efficacy. According to classroom observation records and focus interview results, the researcher realizes that female learners enjoy interacting with games. Feedback and clues of the game will lead to their careful reading of text. The finding is consistent with Prensky (2001) and Squire et al (2005) who indicate that modern teenagers enjoy interactive learning. However, male learners are more eager to pass the challenges rather than understand the situations. They prefer traditional lectures regarding English reading learning. It shows that males do not treat the game as reading material for English learning and they simply regard it as an ordinary game. The finding meets the statement of Prensky (2001) that educational games are treated as common ones.

4 Conclusions and Suggestions

1. Adventure Games effectively increase learning motive of English reading.
Traditional digital learning is boring for learners (Pivec, 2007). However, games can trigger their learning motive. Learners will be involved and concentrated. Thus, game-based learning has gradually become popular in e-learning. In other words, learning by computer games is also part of education. However, the instructors must be careful of the balance among learning goals, instructional activities, classroom time management, and motive. Game-based learning can be properly designed according to teaching materials with different learning objectives, student characteristics, and learning situations to appropriately incorporate games and learning.

2. Adventure Games effectively increase low-achievement learners' English reading confidence, particularly low-achievement males'.
Mitchell and Savill (2004) suggested that game-based learning was significantly criticized due to addiction and violence caused by games. Moreover, many studies (Kuo,2007; O'Leary, Diepenhorst, and Churley-Strom, 2005) indicate that effectiveness between game-based learning and traditional digital learning or traditional instruction is not significantly different. However, according to findings of this study, Adventure Games effectively increase low-achievement students' English reading confidence, particularly for low-achievement males. It shows that game-based learning can result in different possibilities for low-achievement learners. It will rely on future research to develop different learning experiences and opportunities for low-achievement learners.

3. Adventure Games effectively enhance self-efficacy of English reading. However, males do not reveal significant differences.
It can be feasible to apply Adventure Games to English reading learning. However, balancing between games and learning and strategy of game-based learning will rely upon further studies. How to provide learners with appropriate and positive game experience is considerably important. Many past studies (e.g. Ng and Wiemer-Hastings, 2005) demonstrate that current game designs tend to result in learners' indulgence and addiction. Therefore, in game-based learning, teachers should not only instruct students with correct game learning concepts, such as time management, but

also carefully guide the students and select the games for them since there are negative effects such as addiction and violence.

References

1. Chi, F.M.: Discussion as Meaning-Construction in EFL Reading: A study of Taiwanese EFL college learners. Proceedings of the National Science Council, ROC Part C: Humanities and Social Sciences 7(2), 234–244 (1997)
2. Garris, R., Ahlers, R., Driskell, J.: Games, motivation, and learning: A research and practice (2002)
3. Goodman, K.S.: The reading process. In: Carrell, P., Devine, J., Eslkkey, D., Devine, J. (eds.) Interactive Approaches to Second Language Reading, pp. 93–100. Cambridge University Press, New York (1989)
4. Kuo, M.J.: How does an online game based learning environment promote students' intrinsic motivation for learning natural science and how does it affect their learning outcomes? In: Proceedings of the First IEEE International Workshop on Digital Game and Intelligent Toy Enhances Learning, pp. 135–143 (2007)
5. Hidi, S., Anderson, V.: Producing written summaries: task demands, cognitive operations and implications for instruction. Review Educ. Research 56(4), 473–493 (1986)
6. Horwitz, E.K., Horwitz, M.B., Cope, J.A.: Foreign language classroom anxiety. Modern Language J. 70, 125–132 (1986)
7. MacIntyre, P.D., Gardner, R.C.: The subtle effects of language anxiety on cognitive processing in the second language. Language Learning 44, 283–305 (1994)
8. Malone, T.W., Lepper, M.R.: Making learning fun: A taxonomy of intrinsic motivations for learning. In: Snow, R.E., Farr, M.J. (eds.) Aptitude, Learning, and Instruction, III: Conative and Affective Process Analysis, pp. 223–253. Lawrence Erlbaum Associate, Inc., Hillsale (1987)
9. Newgrounds, http://newgrounds.com
10. Mejıás, H., Applebaum, R.L., Applebaum, S.J., Trotter, R.T.: Oral communication apprehension and Hispanics: an exploration of oral communication apprehension among Mexican American students in Texas. In: Horwitz, E.K., Young, D.J. (eds.) Language Anxiety: From Theory and Research to Classroom Implications, pp. 87–97. Prentice-Hall, Englewood Cliffs (1991)
11. Ng, B.D., Wiemer-Hastings, P.: Addiction to the Internet and Online Game. CyberPsych. & Behavior 8(2), 110–113 (2005)
12. O'Leary, S., Diepenhorst, L., Churley-Strom, R.: Educational games in an obstetrics and gynecology core curriculum. American J. Obstetrics & Gynecology 193, 1848–1851 (2005)
13. O' Malley, J.M., Chamot, A.U.: Learning strategies in second language acquisition. Cambridge University Press, Cambridge (1990)
14. Pagulayan, R.J., Keeker, K., Wixon, D., Romero, R.L., Fuller, T.: User-centered design in games. In: Jacko, J.A., Sears, A.E. (eds.) The Human-Computer Interaction Handbook: Fundamentals, Evolving Technologies and Emerging Applications, pp. 883–906. Lawrence Erlbaum Associate, Inc., Hillsale (2003)
15. Pivec, M.: Editorial: Play and learning: potentials of game-based learning. British J. Educ. Tech. 38(3), 387–393 (2007)
16. Prensky, M.: Digital game-based learning. McGraw-Hill, New York (2001)
17. Squire, K.: Game-based learning: Present and future of state of the field (2005), http://www.masie.com/xlearn/Game-Based_Learning.pdf
18. Steinberg, F.S., Horwitz, E.K.: The effect of induced anxiety on the denotative and interpretive content of second language speech. TESOL Quarterly 20, 131–136 (1986)

The Application of Digital Game-Based Learning to Idioms Education Acceptance

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Abstract. This study aims to examine the application of digital game-based learning to idioms education. The questionnaire survey demonstrates that "game-based learning" system is suitable for students of different gender and with different experiences. By technology acceptance model (TAM), the researcher further found that perceived ease of use can predict perceived usefulness. Moreover, perceived ease of use and perceived usefulness can predict use intention. Path analysis shows that digital game-based learning acceptance will be "directly" influenced by learners' perceived usefulness. Therefore, usefulness of the system will be the priority to accepting digital game-based learning. When establishing a strategy of digital game-based learning for university students, we should pay more attention to the learning content in order to promote students' use intention and to enhance learning effectiveness.

Keywords: digital game-based learning, idioms education, technology acceptance model (TAM).

1 Introduction

Regarding research field, instruction, and even application, Digital Game-Based Learning is actively developing (Papargyris & Poulymenakou, 2004; Fullerton, 2006). Piaget (1964) suggested that game-based learning, including knowledge of courses in games meeting students' cognitive and psychological development and applying in animation, would trigger students' learning motive and learning effectiveness. Some studies found that language learning first referred to learners' cognition of words and interpersonal application (Hickmann, 2001). Digital game-based learning in language education can effectively increase learners' perception of language and learning motive and achievement of practice (Donmus, 2010; Turgut & İrgin, 2009). Idioms in language education is a good example. "Idioms" are the short and powerful regular phrases in long-term use of language. They allow people to express their meanings more efficiently (Gibbs & Nayak, 1989; Laval, 2003).

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Thus, this study aims to apply digital game-based learning to idioms education in order to explore the acceptance of university students in non-information departments toward digital game-based learning.

2 Literature Review

1. Implication and study of Digital Game-Based Learning
Digital Game-Based Learning (DGBL) is one kind of game-based learning, and it is developed by Prensky (2001). Barab et al. (2005) suggested that educational computer games could draw students' attention and allow students to develop their cognition and experience with the games. Scholars (Jenkins, 2002; Squire et al., 2003) suggested that "challenging," "unpredictable," and "competitive" of digital games are the drives of game playing. Players' curiosity and internal motive are triggered by their intention to challenge the levels and win. Thus, students can search for the solutions from errors and there is high degree of interaction. It is the important characteristic to enhance the learners' reconstruction of internal cognition and establishment of knowledge. Additionally, digital game-based learning gradually becomes the new model of digital learning (Aldrich, 2004; Squire & Steinkuehler, 2005). Scholars (Garris et al, 2002) suggested that there should be a game incorporating instructional content and game characteristic in digital game-based learning to allow the learners to be involved in the game to accomplish the learning goal.

2. Technology Acceptance Model (TAM)
In order to effectively elaborate the use behavior of information technology users, Davis et al. (1989) adopted Theory of Reasoned Action (TRA) and the situation of information system use to develop the framework of Technology Acceptance Model (TAM). The theory is commonly applied to the study on human beings' behavioral intention (Fishbein & Ajzen, 1975). Behavioral intention is influenced by a person's attitude toward the behavior and subjective criteria (Davis, 1989; Lai et al., 2009). TAM, as the theoretical base, can be applied to probe into the influence of external factors on users' internal belief, attitude, and intention as well as technology use (Davis, 1986). In short, TAM means perceived ease of use and perceived usefulness will influence intention of technology use and further affect actual behavioral performance.

3 Research Method

According to related literatures, a research framework is constructed. The variables include students' perceived ease of use, perceived usefulness, and use intention regarding the system and students' individual difference.

In the research process, the researcher first explains the meaning of each idiom to 60 students and then applies the instruction upon game-based learning (see Figures 1). After the instruction, questionnaire survey is conducted according to the revised scales of Davis et al. (1989) and Lai et al. (2009).

Fig. 1. Game-based learning system: display of idioms game Source: Idioms game (2011)

After expert validity, item analysis and factor analysis, three dimensions and 12 items are obtained: "perceived ease of use" (5 items), "perceived usefulness" (4 items), and "use intention" (3 items). As to reliability test, Cronbach's α is the outcome of test on sub-scales (0.836, 0.837, and 0.838) and total scale (0.908). It demonstrates that the scale is considerably reliable.

4 Data Analyses and Results

1. Difference analyses of different variables on the acceptance toward game-based learning. The statistical results of t-test and ANOVA demonstrate that students' background variables do not reveal significant difference on use intention of "game-based learning" system.
2. Regression analysis. Based on coefficient estimation of stepwise analysis, Beta coefficient is 0.59(p=0.000). It means that there is significant prediction between the independent variable (perceived ease of use) and the dependent variable (perceived usefulness). Additionally, based on coefficient estimation of stepwise analysis, Beta coefficient is 0.63(p=0.000). It means that there is significant prediction between independent variable (perceived ease of use and perceived usefulness) and dependent variable (use intention).
3. Path analysis. Product-moment correlation between "perceived ease of use" and "perceived usefulness" is $r(58)=.59$, $p<.001$; product-moment correlation between "perceived ease of use" and "use intention" is $r(58)=.51$, $p<.001$; product-moment correlation between "perceived usefulness" and "use intention" is $r(58)=.68$, $p<.001$. Therefore, the path of full model is constructed (see Figure 2).

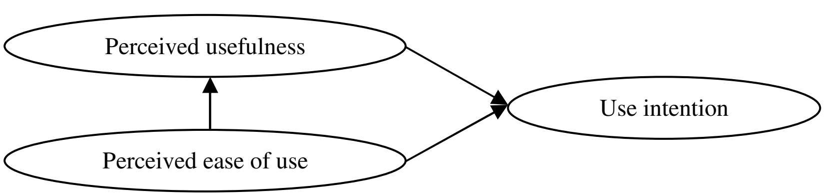

Fig. 2. Path of full model of Digital Game-Based Learning application to Idioms Education acceptance

Path analysis outcome of restriction model demonstrates that t values of all paths are statistically and significantly different (Table 1. Outcome of the path analysis demonstrates that digital game-based learning acceptance will be “directly” influenced by learners’ perceived usefulness. Learners’ perceived ease of use will “indirectly” influence digital game-based learning acceptance through learners’ perceived usefulness.

Table 1. Path analysis of full model of Digital Game-Based Learning application to Idioms Education acceptance

Criterion	Predictors	Normalized coefficient (β)	t	R^2	Residual Variable	F
Use intention	Perceived usefulness	.628	6.146***	.394	.778	37.773***
Perceived usefulness	Perceived ease of use	.592	5.587***	.350	.806	31.214***

*** p<.001

5 Conclusions and Suggestions

Two findings and one suggestion are indicated as criteria for scholars and experts of “game-based learning”.

5.1 Conclusions

1. This study demonstrates that “game-based learning” system is suitable for students of different gender and with different use experience. It will increase the prevalence of the system.
2. In addition, perceived ease of use can predict perceived usefulness, and perceived ease of use and perceived usefulness can predict use intention. Digital game-based learning acceptance will be “directly” influenced by learners’ perceived usefulness, and learners’ perceived ease of use “indirectly” influences digital game-based learning acceptance through learners’ perceived usefulness. The situation is not totally the same as TAM suggested (Davis et al. 1989). This study indicates that the subjects value usefulness instead of ease of use of the system. The former thus becomes the priority for them to accepting Digital Game-Based Learning.

5.2 Suggestions

This study focuses on online “game-based learning,” and future researchers should pay more attention to the learning content when establishing Digital Game-Based Learning strategies for university students in order to promote students’ use intention and learning effectiveness.

References

1. Aldrich, C.: Simulations and the Future of Learning. Pfeiffer, New York (2004)
2. Barab, S., Thomas, M., Dodge, T., Carteaux, R., Tuzun, H.: Making Learning Fun: Quest Atlantis, a Game without Guns. Educational Technology Research and Development 53(1), 86–107 (2005)
3. Davis, F.D.: A Technology Acceptance Model for Empirically Testing New End-user Information System: Theory and Results. Unpublished doctoral dissertation, MIT Sloan of management, Cambridge, MA (1986)
4. Davis, F.D.: Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology. MIS Quarterly 13, 319–340 (1989)
5. Davis, F.D., Bagozzi, R.P., Warshaw, P.R.: User Acceptance of Computer Technology: A Comparison of Two Theoretical Models. Management Science 35(8), 982–1003 (1989)
6. Donmus, V.: The Use of Social Networks in Educational Computer-game Based Foreign Language Learning. Procedia-Social and Behavioral Sciences 9, 1497–1503 (2010)
7. Fishbein, M., Ajzen, I.: Belief, Attitude, Intention, and Behavior: An Introduction to Theory and Research. Addison-Wesley, Reading (1975)
8. Fullerton, T.: Play-Centric Games Education. IEEE Computer, 36–42 (2006)
9. Garris, R., Ahlers, R., Driskell, J.: Games, Motivation, and Learning: A Research and Practice Model. Simulation & Gaming 33(4), 441–467 (2002)
10. Gibbs, R.W., Nayak, N.P.: Psycholinguistic Studies on the Syntactic Behavior of Idioms. Cognitive Psychology 21, 100–138 (1989)
11. Hickmann, M.: Language and Cognition in Development: Old Questions, New Directions. Pragmatics 11(2), 105–126 (2001)
12. Jenkins, H.: Game theory. Technology Review 29, 1–3 (2002)
13. Lai, C.M., Huang, H.M., Liaw, S.S., Huang, W.W.: A Study of User's Acceptance on Three-dimensional Virtual Reality Applied in Medical Education. Bulletin of Educational Psychology 40(3), 341–362 (2009)
14. Laval, V.: Idiom Comprehension and Metapragmatic Knowledge in French Children. Journal of Pragmatics 35, 723–739 (2003)
15. Papargyris, A., Poulymenakou, A.: Learning to Fly in Persistent Digital Worlds: The Case of Massively Multiplayer Online Role Playing Games. ACM SIGGROUP Bulletin 25(1), 41–49 (2004)
16. Piaget, J.: Cognitive Development in Children: Development and Learning. J. of Research in Science Teaching 2, 176–186 (1964)
17. Prensky, M.: Digital Game-Based Learning. McGraw-Hill, New York (2001)
18. Squire, K., Jenkins, H., Holland, W., Miller, H., O'Driscoll, A., Tan, K.P., Todd, K.: Design Principles of Next-Generation Digital Gaming for Education. Educational Technology 43(5), 17–23 (2003)
19. Squire, K., Steinkuehler, C.: Meet the Gamers. Library J. 130(7), 38–42 (2005)
20. Turgut, Y., İrgin, P.: Young Learners' Language Learning Via Computer Games. Procedia - Social and Behavioral Sciences 1(1), 760–764 (2009)

Using Web 2.0 Social Networking to Enhance Collaborative Learning in Preparing Graduation Events

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Abstract. This article reports on research that attempted to find out how physical education professionals in the university environment are responding to the increasing importance and visibility of web 2.0 tools and social networking in Taiwan. The purpose of the study is to explore how the web 2.0 social networking and its influence on college students' learning behavior in preparing graduation events. Two hundred and sixty-nine individuals voluntarily signed up a group, "Sport Broadway in NCUE", for the annually graduation events on Facebook. Total 512 postings and responses had been posted and 2434 likes were collected and analyzed by quantitatively and qualitatively. Descriptive statistics in quantitative data and constant comparison in qualitative information were analyzed with the SPSS 15.0 and QSR Nvivo 7. The results identified that announcement, sharing feelings, encouragement, asking questions, and critiques are five major functions of posting. In addition, "like" which means "agree" and easy positive feedback in Facebook was given most frequently when critiques and sharing encouragement. The finding showed that Web 2.0 social networking are viable way to motivate colleague students to collaborate and learn to accomplish tasks and to overcome challenges. However, the quality of posts and comments were easily out of control when the levels of stress rises and emotions come. The study implicates that Web 2.0 social networking is worth to promote and to be developed as an educational tool in college levels.

Keyword: Web 2.0, Social Network, Collaborative Learning, Sport, Physical Education.

1 Introduction

Web 2.0 social networking are using web 2.0 technology and its web-based service sites to construct a public or semi-public profiles within a bounded system and provide opportunities for individuals to share connections, views, and social network connections within the system [1]. The first social networking site was lunched in 1997 [2]. Since then, more and more evolutional tools and technology had been improved to provide a more effective communication and collaboration without barrier

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regarding time, place, and culture boundaries [1]. Web 2.0 which includes blogs, podcasts, wikis, photo sharing, social bookmarking, collaborative document tools, instant messaging, mash-ups, and really simple syndication (RSS), and others, is not only an advanced user interface but also a new way of thinking from concept through delivery and from marketing through support [3]. One of the most recognizable web 2.0 social networking site is Facebook which began in early 2004 as a Harvard-only social networking site [4]. The Facebook website were launched in February 2004 and has more than 600 million active users as of January 2011 [5].

The theoretical framework of the study drives from collaborative learning theories. From social-cultural and social-constructivist perspective of learning, the approach of collaborative learning believes that learners can learn more through collaborative work with their peers and active participation [6]. In social-cultural theory, learning which is described as participation into communities and in the way appropriating the tool encourages student no only passively memorizing facts presented by teachers but also using their previous knowledge and experience to construct their new knowledge. Collaborative learning helps learners to adapt new situation and problem solving by providing triggering situations for cognitive conflicts and locating cognitive gaps that need to be connected [7, 8].

Student learning will increase via web 2.0 due to personal engagement, use of preferred learning-styles, and application to daily life [9]. A study also points out that social networking sites are applicable for collaborative learning because they support interaction and users' communal active roles. In addition, they also found that this application allows: (1) capturing learners' ideas and unique interpretations, (2) using them as a further source of advanced steps of learning, and (3) gaining benefits from mobile technologies because they provide a means for realizing theories of collaboration which previously has been challenging in lecture-based courses [10]. However, there is a lack of using this technology on collaborative learning in non-classroom environment, especially in physical education. The aim of the study is to bridge the gap between those research areas.

2 Methodology

A total of 269 participants were signed up the group of "Sport Broadway in NCUE" on the Facebook (Fig. 1). Most of them were undergraduate students who participated the event and performed in the show. However, alumni, instructors, professors, friends and fans of the annual events also signed up the group. After signing up, each individual would receive email and have the right to posting, writing feedback and pressing "like" to express his/her immediate response to the process of preparing the events.

Data were collected from the Facebook website (https://www.facebook.com/) since December to May 30, 2011. A total of 512 posts and its responses which were already collected from 269 individuals until May 30, 2011 had reached the saturated level of data collection and its representation. Qualitative data were imported to QSR*Nvivo7. Constant comparison was utilized to analyze the qualitative information.

Fig. 1. Group description of Sport Broadway on Facebook

3 Results

After reviewing all postings, a total of 512 postings were categorized as six types of postings. Table 1 shows the distribution of the postings in the group. According to the table, "Announcement" is the most frequently type of postings in this group. It included announcement of the practice time, gathering time, things to bring, and locations to gather. A total of 2434 likes also analyzed with those six types of postings. We found that each critiques got the most likes in the study.

Table 1. Descriptive statistics of postings

Type of Postings	Number of Postings (%)	Number of Likes (%)	Average of Likes
Announcement	303 (59.1%)	1094	3.61
Sharing Feelings	62 (12.1%)	481	7.70
Encouragement	45 (8.8%)	549	12.20
Asking Questions	16 (3.1%)	55	3.43
Critiques	12 (2.3%)	220	18.33
Other Issues	74 (14.4%)	35	0.47
Total	512(100%)	2434	4.75

Qualitative results identified that this web 2.0 social networking enhanced collaborative learning in preparing this graduation events by providing the four major functions which included brainstorming, emotional expression, reciprocal care, and group identity to attract students to keep involved with this event. Immediate feedback, convenience, enjoyment, and multimedia are four keys to provide those functions.

3.1 Emotional Expression

Most of students used this social networking to express their emotion about the practice sessions. They often simply used "like" to express but sometime they would post a paragraph of assay to express their feelings.

3.2 Brainstorming

Brainstorming is the first theme that could be observed in those postings. According to the nodes of collected postings, the Facebook provided a platform by allowing text, audio and visual clips to enhance the brainstorming. Students were easy to gather other feedback by posting their thoughts on the Facebook.

3.3 Reciprocal Care

Reciprocal care is another theme that generated from the postings and responses. They not only encouraged each other to keep practicing every session, but also encouraged their performance in the practice sessions by sharing tips. In addition, they were caring each other for safety and health conditions. For example, a graduate student expressed her care to all students who participate in the event via this platform. She reminded all students should have to be careful about the traffic safety and drive slowly due to the raining days.

3.4 Group Identity

There were lots of group identify postings in the group, such as “we are family”, “strong sportsmanship” and “spirit of physical education”. This group-identity motivated students to keep involved and practicing for the event. For example, the head of this organizing committee expressed his recognition of their progress and reminded all members that they have the “spirit of sportsman”.

4 Discussion

A major strength of this study was to provide an empirical evidence for using web 2.0 social networking to facilitate a collaborative learning environment and completing a goal-oriented task. Through the process of participating web 2.0 social networking, those students were tied together and became a strong team for the task. The study also extends the empirical support that web 2.0 social networking that focused on enhancing collaborative learning in non-classroom learning. Through analyzing their participation in a graduation event by web 2.0 networking, we found that this is a viable approach in higher education. Comprehensive and holistic intervention type studies of the response to web 2.0 social networks with other modes of application are recommended to expand the evidence base for this new approach.

5 Conclusions

The study gives insight on how Web 2.0 social networkings were used to enhance college students to enhance their collaborative learning in preparing graduation events. The research findings showed that Web 2.0 social networking are viable way to attract college students to participate the events intrinsically. Further studies on other event participation are suggested to understand the generalization of the uses of Web 2.0 social networking.

References

1. Olasina, G.: The Use of Web 2.0 Tools and Social Networking Sites by Librarians, Information Professionals, and Other Professionals in Workplaces in Nigeria. PNLA Quarterly 75(3), 11–43 (2011)
2. Boyd, D.M., Ellison, N.B.: Social network sites: Definition, history, and scholarship. J. Computer Mediated Communication 13(1), http://jcmc.indiana.edu/vol13/issue1/boyd.ellison.html
3. Lemley, T., Burnham, J.F.: Web 2.0 tools in medical and nursing school curricula. J. Med. Libr. Assoc. 97(1), 49–51 (2009)
4. Cassidy, J.: Me media: How hanging out on the Internet became big business. The New Yorker 82(13), 50 (2006)
5. Eldon, E.: Growth Puts Facebook in Better Position to Make Money (2008), http://venturebeat.com/2008/12/18/2008-growth-puts-facebook-in-better-position-to-make-money/
6. Dillenbourg, P., Baker, M., Blaye, A., O'Malley, C.: The evolution of research on collaborative learning. In: Spada, E., Reiman, P. (eds.) Learning in Humans and Machine: Towards an Interdisciplinary Learning Science, pp. 189–211. Elsevier, Oxford (1996)
7. Dillenbourg, P.: What do you mean by collaborative learning? In: Dillenbourg, P. (ed.) Collaborative-learning: Cognitive and Computational Approaches, pp. 1–19. Elsevier, Oxford (1999)
8. Weinberger, A.: Scripts for computer-supported collaborative learning. In: Effects of Social and Epistemic Cooperation Scripts on Collaborative Knowledge Construction. Ludwig-Maximilian University, Munich (2003)
9. Brown, N.E., Bussert, K.: Information Literacy 2.0: empowering Students through Personal Engagement. Online Submission (2007)
10. Vesisenaho, M., Valtonen, T., Kukkonen, J., Havu-Nuutinen, S., Hartikainen, A., Karkkainen, S.: Blended Learning with Everyday Technologies to Activate Students' Collaborative Learning. Sci, Educ. Int. 21(4), 272–283 (2010)

A Pilot Study of Taiwan Elementary School Students Learning Motivation and Strategies in Robotics Learning

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Abstract. The purpose of this study is to investigate the relationship between learning motivation and learning strategies in robotics learning. 37 elementary school students participated in this study. The RMSLQ questionnaire was used to collect data about student learning motivation and learning strategies in robotics learning. The results indicated that students showed high motivation and used a variety of learning strategies in learning robotics. Moreover, form the result of correlation analysis, it was found that both cognitive and meta-cognitive strategy and resource management strategy had significant positive correlation with students' control believe. In the future, more attention should be paid on developing different learning activities or learning mechanisms to improve students' control belief in learning robotics to improve their leaning strategies.

Keywords: Robotics, learning motivation, learning strategies, MSLQ.

1 Introduction

Recently, different technologies, such as games and robots, gradually were applied into educational fields[1][2][3]. Robotics education received more attention, not only in higher education, but also in secondary and primary education [4][5]. The invention of programmable bricks, like Lego NXT or Wedo decreased the barriers to learn robotics, and make it possible for young children to learn how to assemble robots and learn how to write programs for their robots [6][7][8].

Pintritch et al. considered three motivation factors, like: value, expectancy, and affection would be affect one's learning. Moreover, Pintritch et al concluded two kinds of learning strategies: cognitive and meta-cognitive strategies, and resource management. In the cognitive and meta-cognitive learning strategies, five elements were included: Rehearsal, elaboration, organization, critical thinking, and meta-cognitive self-regulation. In resource management strategies, four elements were included: time and study environment, effort regulation, Peer learning, and help seeking [9][10].

Liu, Lin & Chang investigated students' self-regulation strategies and satisfaction in robotics courses, and the result indicated that students' self-regulation strategies were improved [6]. The main purpose of this study was to investigate Taiwan elementary

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school students' learning motivation and learning strategies in learning robotics, and it was hope that the result could be used to improve the design of teaching model of robotics education.

2 Methodology

2.1 Participants

The participants of this study were thirty-seven elementary school students who participated in the World Robot Olympiad 2010(WRO 2010). Thirty students were male, and seven students were female. Among the thirty-seven students, five were third grade students, five were fourth grade students, eleven were fifth grade students, and sixteen were sixth grade students.

2.2 Robotics Motivated Strategies for Learning Questionnaire (RMSLQ)

The questionnaire was adapted from the motivated strategies for learning questionnaire (MSLQ) developed by Pintritch et al. [9]. Three experts were invited to evaluate the suitability of the content of this questionnaire. This questionnaire included two sub-scales: learning motivation subscale and learning strategies subscale. In the learning motivation scale, six factors were included: intrinsic goal orientation (Cronbach's Alpha= .83), extrinsic goal orientation (Cronbach's Alpha= .85), task value (Cronbach's Alpha= .80), control believe (Cronbach's Alpha= .83), self-efficacy (Cronbach's Alpha= .73), and learning anxiety (Cronbach's Alpha= .91). There are 23 items in learning motivation subscale. The reliability analysis of learning motivation subscale indicated that the value of Cronbach's Alpha of all the factors were higher than .7, and it showed the subscale had good reliability.

In the learning strategy scale, two dimensions were included: cognition and meta-cognition strategy and resource management. The cognition and meta-cognition strategy includes five factors: rehearsal (Cronbach's Alpha= .85), elaboration (Cronbach's Alpha= .86), organization (Cronbach's Alpha= .90), critical thinking (Cronbach's Alpha= .88), and self-regulation (Cronbach's Alpha= .83). The resource management strategy includes five factors: time management (Cronbach's Alpha= .91), effort regulation (Cronbach's Alpha= .91), peer learning (Cronbach's Alpha= .88), help seeking (Cronbach's Alpha= .87), and information seeking (Cronbach's Alpha= .88). There are 48 items in learning strategy subscale. The reliability analysis of learning strategy subscale indicated that the value of Cronbach's Alpha of all the factors were higher than .7, and it showed that the subscale had good reliability.

3 Results

3.1 Students' Learning Motivation and Strategy in Learning Robotics

The result showed the learning motivation of elementary school students participating in WRO2010 was high, and it indicated the students had high motivation in learning robotics. It is worth noting that the mean of the factor, learning anxiety, is the lowest, and the value of standard deviation of this factor is greatest among the six factors. The result imply that students had some anxiety in learning robotics, and great standard deviation indicated there is a greater difference about perceived learning anxiety among students. Additionally, the result also showed the learning strategies used by elementary school students participating in WRO2010, and the result indicated that the mean of all factors were high, and it showed that when students learned robotics, they would try to apply different to support their learning (Table 1).

Table 1. Descriptive analysis of students' motivation and strategy in learning robotics

Subscales	Factors	Mean	SD
Learning motivation	Intrinsic goal orientation	4.46	.73
	Extrinsic goal orientation	3.94	.99
	Task value	4.33	.72
	Control believe	4.37	.69
	Self-efficacy	4.17	.73
	Learning anxiety	3.78	1.04
Learning strategy	Rehearsal	4.06	.86
	Elaboration	4.00	.85
	Organization	4.19	.76
	Critical thinking	4.22	.71
	Self-regulation	4.19	.78
	Time management	4.22	.80
	Engagement	4.32	.76
	Peer-learning	4.22	.80
	Help-seeking	4.18	.83
	Information-seeking	3.96	.96

3.2 The Correlation between Motivation and Strategy in Robotics Learning

The purpose in this study is to explore the relationship between student's learning motivation and learning strategy in robotics learning. The result indicated the cognition and meta-cognition strategy had significant low positive correlation with students' control believe. This indicated when students have higher control believe with learning robotics, they will use more cognition and meta-cognition to learn robotics. Additionally, the result indicated resource management strategy was shown significant correlation with intrinsic orientation, extrinsic orientation, and control believe. This finding indicated when students have higher intrinsic motivation, extrinsic motivation, and control believe, they will used more resource management strategy (Table 2).

Table 2. Correlation analysis of learning motivation and strategies in robotics learning

	Cognition and meta-cognition strategy	Resource management	Intrinsic goal orientateon	Extrinsic goal orientation	Task value	Control believe	Self Efficacy	Learning anxiety
Cognition and meta-cognition strategy	1	.85***	.31	.28	.26	.33*	.17	.04
Resource management		1	.39*	.45**	.30	.37*	.28	.14
Intrinsic goal orientateon			1	.57**	.80***	.80***	.75***	.29
Extrinsic goal orientateon				1	.51**	.54**	.57***	.26
Task value					1	.85***	.79**	.32*
Control believe						1	.80***	.35*
Self-efficacy							1	.36*
Learning anxiety								1

**p<.05 **p<.01 ***p<.001*

4 Conclusion and Discussion

The purpose of this study is to investigate Taiwan elementary school students' learning motivation and learning strategies in learning robotics, and further to explore the relationship between learning motivation toward learning strategies.

The result indicated that students participated in WRO2010 showed high motivation and used a variety of learning strategies in learning robotics. Moreover, from the result of correlation analysis, it was found that both cognitive and meta-cognitive strategy and resource management strategy had significant positive correlation with students' control believe. This finding implies that students' control believe was an important element in robotics learning. In the future, more studies could design different mechanisms to enhance students' control believe in learning robotics, and further to examine the effect on students' learning performance.

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References

1. Liu, E.Z.F., Lin, C.H.: Developing Evaluative Indicators for Educational Computer Games. British Journal of Educational Technology 40(1), 174–178 (2009)
2. Feng, H.C., Lin, C.H., Liu, E.Z.F.: Parents' Perceptions of Educational Programmable Bricks for Kids. British Journal of Educational Technology 42(2), E30–E33 (2011)
3. Liu, E.Z.F.: Early Adolescents' Perceptions of Educational Robots and Learning of Robotics. British Journal of Educational Technology 41(3), E44–E47 (2010)
4. Chang, C.W., Lee, J.H., Wang, C.Y., Chen, G.D.: Improving The Authentic Learning Experience by Integrating Robots into The Mixed Reality Environment. Computers & Education 55(4), 1572–1578 (2010)
5. Chang, C.W., Lee, J.H., Chao, P.Y., Wang, C.Y., Chen, G.D.: Exploring The Possibility of Using Humanoid Robots As Instructional Tools for Teaching A Second Language in Primary School. Educational Technology & Society 13(2), 1–24 (2010)
6. Liu, E.Z.F., Lin, C.H., Chang, C.S.: Student Satisfaction and Self-Efficacy in A Cooperative Robotics Course. Social Behavior and Personality: An International Journal 38(8), 1135–1146 (2010)
7. Liu, E.Z.F., Kou, C.H., Lin, C.H., Cheng, S.S., Chen, W.T.: Developing Multimedia Instructional Material for Robotics Education. WSEAS Transactions on Communications 7(11), 1102–1111 (2008)
8. Liu, E.Z.F., Cheng, S.S., Lin, C.H., Chang, Y.F., Chen, W.T.: The Development of Evaluation Indicators for LEGO Multimedia Instructional Material. WSEAS Transactions on Computers 7(10), 1782–1791 (2008)
9. Pintrich, P.R., Smith, D.A.F., Garcia, T., McKeachie, W.J.: A Manual for The Use of The Motivated Strategies for Learning Questionnaire (MSLQ). National center for research to improve postsecondary teaching and learning. University of Michigan, Ann Arbor (1991)
10. Liu, E.Z.F., Lin, C.H.: The Survey Study of Mathematics Motivated Strategies for Learning Questionnaire (MMSLQ) For Grade 10–12 Taiwanese Students. The Turkish Online Journal of Educational Technology 9(2), 221–233 (2010)

A Survey on Storytelling with Robots

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Abstract. This paper surveys some works on storytelling with robots. It tries to list type of robot used, who is the user of the system built, what is the focus of the study, and what is the outcome of the study. Most of the users are children, either normal or those with disabilities. The focus of the study includes robots as learning companions/pets, robot programming, interaction design techniques, technology introduction and pedagogy (robots as learning materials), and robots as teaching assistance. Meanwhile, the outcomes are a prototype, learning environment, authoring environment, and pedagogy experience.

Keywords: storytelling, robots, educational robot.

1 Introduction

Robots are engaging, motivating, encouraging imagination and innovation, and may improve literacy and creativity, especially for children. Children interest in robot may be due to its similarity doll and pet animals. Furthermore, it is argued that both male and female have the same interest but in different ways [1]. In [2, 3], educational robots are categorized into three types: learning materials, learning companions / pets, and teaching assistants. On the other hand, storytelling robots may be functioning as educational robots or not. The case of non educational robots can be seen, for example, in [4], the robot there played assistive task to meet therapeutic goals. D. Feil-Seifer & Mataric [5] lists assistive tasks, including: tutoring, physical therapy, daily life assistance, and emotional expression. In this case, the emotional expression task is highly related to storytelling.

Storytelling in general sense has been adopted by the human race to convey knowledge from generation to generation. Written in [6], "... storytelling has been a way to preserve culture and history, communicate ideas and feelings, and educate learners young and old." As new technologies found, they tend to be included in storytelling, storytelling with new technologies. The media may vary from the old one,

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pictures scarped in stones, to the new ones, such as digital media boosted with the Internet. In the case of robots, this may represent the extension of old storytelling habits with puppetry, traditional theater, dolls, or pets.

With robots, physical environment can be created instead of virtual environment. The advantage of physical environment is that many things and information can be sensed "via our sight, hearing, olfaction, palate and tactus" [7]. On the contrary, virtual environment also has its own advantages: it is less dangerous; it can be much less expensive; and it is possible to enter inaccessible places [8].

This paper surveys robot storytelling. The papers collected were mostly from Google Scholar search by using keywords 'allintitle: storytelling robot,' that is, papers having words in its title, 'robot' and 'storytelling'. Simple discussion is based on users, focus of the study, and outcome.

2 Categorization

This section is divided into four sub-sections on types of robot/machine used, users, focus of the study, and outcome.

2.1 Types of Robot/Machine Used

Table 1 shows a list of studies and respective robot/machine used in the study. Worth noting is the work in [9] in which a simple robot very similar to an inexpensive radio-controlled toy car was used in creating a mobile mixed reality environment using a system called GENTORO.

Table 1. Robot/machine type used in storytelling with robot

Type	Paper
Handyboard	[6] [10]
LEGO Mindstorms kit	[11]
Custom made	[4] [12]
Robosapien V2	[13]
PaPeRo (NEC Corp)	[14]
LEGO Mindstorms kit	[15]
Pleo	[16]
(a simple robot)	[9] [17]

2.2 Users

Children. PETS [6] is designed for elementary-school-age children. Animal form of robot is chosen because of children interest in animal to ignite imagination and curiosity. Children are especially interested in things and activity with physical involvement. Besides, storytelling is also a part of a childhood ingredient in that children tend to do a storytelling on their own. In this system, children can create a robotic pet by assembling its parts, create a story with robot emotions and behavior throughout it. The machine behind the robot was Handyboard.

Also targeting at elementary school children [13], a robot was made to become programmable by the children to do a storytelling task. The children can teach the robot to tell stories by first writing English stories supported by story guideline and picture cue via a story write interface. The children then speak each sentence in the story for the robot to learn.

In another work, children were facilitated in their storytelling with tangible props by combining physical and digital authoring environment [16]. The system also supported variation in children performance style between verbalizers (those who talk more and draw less) and visualizers (those who draw more but talk less) and applied a pluralistic programming approach to easily control and program Pleo's behavior. Meanwhile, in [17], a mobile environment and tool, called GENTORO, also for children storytelling was made. The mobility was made possible due to the use of a handheld projector to create a scene on a horizontal area.

Disabled Children. Also targeting at children but those with disabilities, C. Plaisant et al. [4] described the development of a prototype storytelling robot "to motivate the children and help them reach their therapy goals through therapeutic play." Storytelling ingredient was included to provide long term motivation in doing therapy exercise. Therapy goals may be reached for physically challenged children through muscles or for development disabled children through joints exercising or story reflection [12].

Similarly, targeting at children with intellectual disabilities and/or autism, a new learning environment with a prototype personal robot PaPeRo from NEC Corp as its major part was created to enhance children's storytelling tasks and to assist them in producing email text [14]. The robot was involved in a classroom interaction. It can recognize each student via student's ID tag.

Adult (Teachers) and Children. In [11], teachers and students in four Irish primary schools as part of "Empowering Minds" collaborative project between MIT Media Lab, St. Patrick'c College, and the primary school teachers were involved in a framework to develop technological fluency and to use technology within the schools. The teachers without previous experience with Mindstorms were recruited in a workshop to gain design experience that can be transferred to their students.

Similar with the above study but with the context of Portuguese elementary school education, a qualitative case study with two robotics projects was carried out in 4th and 6th grade [15]. The children did robot construction and programming aiming at dramatization of a story and doing storytelling projects: fashion show and dance choreography. In this study, teachers were not explicitly mentioned as the target of the study, though of course they were involved during the learning process.

2.3 Focus of Study

Robots as Learning Companions/Pets, Robot Programming. Using custom interfaces designed for the children to interact with, the robot was designed to accompany the children to be taught in doing a storytelling [13]. The robot can be programmed to tell a story enhanced with movements, background music, and sound effect. This way, children interest in learning English may be triggered by more practice in speaking and their worry in oral task may decrease.

In [16], Pleo robot interacted with children via enhanced children drawings in cards and the robot can be programmed to behave accordingly via the GUI interface. The children also can touch part of Pleo as another method of interaction. They played with Pleo while programming, adding audio narration, and creating a story. Thus, physical environment was created for children to easily play with, combined with a digital authoring environment. With a different approach, simple robot path instruction by children was provided in story rendering part in which children can draw the robot path [17]. In this work, no story design tool was provided because the focus was on story rendering and expression.

Design Techniques. PETS [6] stressed on design experience in a mixed-age design team between adult and children. Although it relates the product with educational applications, during the process, it applies cooperative inquiry and iterative prototyping design techniques. Lesson learned from this, ignited the creation of a more specialized prototype for disabled children with specific user scenarios [4].

Technology Introduction and Pedagogy (Robots as Learning Materials). In [11], robot technology was introduced first to teachers and later from the teachers to their students. Using project-based learning to reveal how children learn a technological concept. Narrative was used to scaffold the work of the children. Technical and pedagogical issues were revealed from the activities in projects for the possibility to pedagogical change.

Another successful educational robot study was similarly implemented with storytelling projects [15]. In this project, three steps were applied: study preparation introducing the basics of LEGO Mindstorms platform, storytelling project development, and final result presentation to the community.

Robot as Teaching Assistance. Robot as teaching assistance differs in robot as learning companion in its main user. In the case of teaching assistance, the users are teachers, whereas in learning companion the users are students [18]. In [14], a robot was used in classroom-based language learning with a more child-friendly interface that can do human-like communication, with environment structure fitted to children with disabilities. The learning environment was structured so a personal robot supported teaching/learning activities in regular language lessons.

2.4 Outcome

Design Experience. Design experience gained in PETS [6] includes some guiding principles on how to cooperate between adult and children about new power structures, similarity in voice that is completely different from children's school culture, and requirement to create a convenient design environment.

Pedagogic Experience. In [11], three out of eight classroom projects were explained. Different stories were given for each project to scaffold the project creation using LEGO Mindstorms materials. Primary school students were introduced with these materials. It was proven that the children could understand and apply complex design under the supervision of already trained teachers. Storytelling (narrative) was used as a scaffold in building the projects.

In [15], children could build and program the robots for specific tasks. A pedagogical context to new technologies was provided by integrating much information available. In this case, critical and logical thinking was built, while interaction and autonomy as well as interest and motivation for learning were increased.

Prototype. Those stressing with design techniques and user interaction [4], [6], [10], prototypes were produced, and in future work, robot toolkit consisting of a base robot and accessories may be produced.

Authoring Environment. A storytelling authoring (programming) environment for children to be performed a robot [13] was built in GUI fashion. The facility was aimed at motivating the children in learning English as a second language. As children create the story, teach, and speak it to the robot, they learn speaking skill. They do not need to feel shy or funny because their partner is just a robot. Like animals, for the children, robot is viewed as a non-threatening and non-judgmental creature [19].

More than using GUI, a mixed physical and digital authoring environment was produced in [16]. The environment can be used by the children to create their stories using enhanced drawings interacted with GUI to manipulate Pleo robotic characters. The manipulation can also be done by using physical touch, thus resulting in multimodal tools to make creative storytelling.

Learning Environment. A personal robot from NEC corp, PaPeRo, in a new learning environment, was used in front of a class with teacher-led activities to encourage students with intellectual disabilities and/or autism to tell more stories [14]. It was shown that there was a constant increase in story length and story grammatical complexity the children produced.

Mixed Environment. A system, called GENTORO, using a robot and a handheld projector was designed to create a mixed environment integrating physical and virtual spaces [17]. It can help children in storytelling, both design and expression of creative and original stories. The robot played as the character of the story, permitting children embodied participation due to mobile nature of the handheld projector and the robot. The system built enables the children to make a robot perform their created story in a physical area [9]. The environment thus created is a mobile mixed reality environment.

3 Final Remarks

Users of storytelling robots mostly are children. Children learning, in Papert's opinion, should be constructionistic rather than instructionistic. "In the constructionist approach, students learn from designing and assembling their own robots" [2]. Another type of users is children with disabilities. With this type of users, the system designed should play therapeutic and restoration functions.

Works with the title containing the word 'storytelling' and 'robot' are still few. This may indicate that researches in this area are still promising and need to be done. The possibility of mixing among storytelling, children, and a robot vary as follows: a robot is given a storytelling feature to perform before the children; children are permitted to do programming and story designing for the robot to perform; a robot is designed to motivate children to do storytelling; children are facilitated to assemble a robot character and its environment and they create a story for the robot to act on; a robot is programmed by a teacher to perform teaching assistantship (including storytelling), for example, in a language learning class; and so on. Complexity may be increased by adding more than one robot character. The application context variations among others may include: interaction design experience, education and learning, assistive function, pedagogy, instructional design, and learning environment.

Besides, the robots give a physical touch in a physical environment. Combined with a virtual environment, a storytelling robot becomes an immersive environment for children to express their story [17]; therefore, a mixed reality environment is created. This environment is what we call as the Digital Learning Playground (DLP) currently we have been working with [20].

References

1. Johnson, J.: Children, robotics, and education. Artif Life Robotics 7, 16–21 (2003)
2. Chang, C.W., Lee, J.H., Chao, P.Y., Wang, C.Y., Chen, G.D.: Exploring the possibility of using humanoid robots as instructional tools for teaching a second language in primary school. Educational Technology & Society 13, 13–24 (2010)
3. Li, L.-Y., Chang, C.-W., Chen, G.-D.: Researches on Using Robots in Education. In: Chang, M., Kuo, R., Kinshuk, Chen, G.-D., Hirose, M. (eds.) Learning by Playing. LNCS, vol. 5670, pp. 479–482. Springer, Heidelberg (2009)
4. Plaisant, C., Druin, A., Lathan, C., Dakhane, K., Edwards, K., Vice, J.M., Montemayor, J.: A storytelling robot for pediatric rehabilitation. In: Proceedings of the Fourth International ACM Conference on Assistive Technologies, pp. 50–55 (2000)
5. Feil-Seifer, D., Mataric, M.J.: Defining socially assistive robotics, pp. 465–468 (2005)
6. Druin, A., Montemayor, J., Hendler, J., McAlister, B., Boltman, A., Fiterman, E., Plaisant, A., Kruskal, A., Olsen, H., Revett, I., Schwenn, T.P., Sumida, L., Wagner, R.: Designing PETS: a personal electronic teller of stories. In: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems: The CHI is the Limit, pp. 326–329 (1999)
7. Hsu, S.-H., Chou, C.-Y., Chen, F.-C., Wang, Y.-K., Chan, T.-W.: An investigation of the differences between robot and virtual learning companions' influences on students' engagement, pp. 41–48 (2007)
8. Danilicheva, P., Klimenko, S., Baturin, Y., Serebrov, A.: Education in Virtual Worlds: Virtual Storytelling, pp. 333–338 (2009)
9. Sugimoto, M.: A Mobile Mixed Reality Environment for Children's Storytelling using a Handheld Projector and a Robot. IEEE Transactions on Learning Technologies, 1–1 (2011)
10. Montemayor, J.: PETS: A Personal Electronic Teller of Stories. Robots for Kids: Exploring New Technologies for Learning 73 (2000)

11. Martin, F.G., Butler, D., Gleason, W.M.: Design, story-telling, and robots in Irish primary education. In: 2000 IEEE International Conference on Systems, Man, and Cybernetics, vol. 1, pp. 730–735 (2000)
12. Lathan, C., Vice, J.M., Tracey, M., Plaisant, C., Druin, A., Edward, K., Montemayor, J.: Therapeutic play with a storytelling robot. In: CHI 2001 Extended Abstracts on Human Factors in Computing Systems, pp. 27–28 (2001)
13. Lu, Y.-T., Chang, C.-W., Chen, G.-D.: Using a Programmable Storytelling Robot to Motivate Learning Second Language. In: Seventh IEEE International Conference on Advanced Learning Technologies, ICALT 2007, pp. 841–844 (2007)
14. Munekata, T., Fujita, Y., Nishizawa, T.: New learning environment for enhancing storytelling activities of children with intellectual disabilities/autism using a personal robot in the classroom (2009)
15. Ribeiro, C.R., Coutinho, C.P., Costa, M.F.M.: Robotics in child storytelling. Presented at the International Conference on Hands-on Science, India (2009)
16. Ryokai, K., Lee, M.J., Breitbart, J.M.: Children's storytelling and programming with robotic characters. In: Proceeding of the Seventh ACM Conference on Creativity and Cognition, pp. 19–28. ACM, New York (2009)
17. Sugimoto, M., Ito, T., Nguyen, T.N., Inagaki, S.: GENTORO: a system for supporting children's storytelling using handheld projectors and a robot. In: Proceedings of the 8th International Conference on Interaction Design and Children, pp. 214–217 (2009)
18. Chen, G.-D., Chang, C.-W.: Using Humanoid Robots as Instructional Media in Elementary Language Education, pp. 201–202 (2008)
19. Lee, J.J.: Reading with Robots (2009)
20. Wang, C.-Y., Chi-Hung, C., Chia-Jung, W., Yu-Ling, C., Jih-Hsien, L., Chen, G.-D.: Constructing a Digital Authentic Learning Playground by a Mixed Reality Platform and a Robot. In: Proceedings of the 18th International Conference on Computers in Education, pp. 121–128. Asia-Pacific Society for Computers in Education, Putrajaya (2010)

Design a Partner Robot with Emotions in the Mixed Reality Learning Environment

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Abstract. In this paper, we propose a partner robot with emotions in the mixed reality learning environment. The learning environment is designed into a task-based scenario. Students can acquire knowledge by interacting with the robot which has emotions and responses. Referring to the experiment, we found the robot played an essential role engaging students. Students showed their strong preference learning with the robot and their motivation, involvement, pleasure, and learning effectiveness also increase in the learning process.

Keywords: robot, mixed reality, task-based learning, digital learning playground.

1 Introduction

The question of how to have an effective learning and teaching has always been a burning issue worldwide [1]. In accordance with Dewey's experiential learning, true learning only occurs in relevant experience [2]. A proverb, "Tell me and I'll forget; show me and I may remember; involve me and I'll understand" also indicate how important experience is [1]. As just mentioned, "relevant contexts" and "actual experience" are essential to learning. Thus, this is evident in the large number of recent publications relating to task-based learning and teaching. A task is an activity which requires learners to use language, with the emphasis on meaning, to attain an objective, and which is chosen so that it is most likely to provide information for learners and teachers which will help them in their own learning [3].

Robot technology has matured enough not only to help people work, but also to offer possible educational applications, for instance, serving as learning materials, learning companions, and teaching assistant for teachers and kids. Many researchers proposed that the participation, concentration, and affection of students could be improved when a robot was appropriately integrated into the learning activity [4]. For example, the iRobi series are equipped with screens that can support playback of multimedia teaching materials. However, there were few robots applications that were integrated in task-based learning. Although iRobi could help engage students while at

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the same time provide assistance in teaching, students still passively receive knowledge. We have seen a great potential of joining robots in task-based learning.

With the rapid development of information technology, the context design of learning activities can be varied and more flexible. HIT lab in George Washington University designed MagicBook, which is an MR interface that transports users between reality and virtuality [5]. According to the experimental results, both mixed reality implementations could enhance on simulating an interactive environment. Therefore, there is a potential to create tasked learning environment for more interaction and engagement with mixed reality's assistance.

As mentioned above, we applied MR technology to create a contextual learning platform with a tasked agent, the robot. The associated contexts (environment) and assigned tasks provide students to experience the knowledge what they have learned and promote their immersion and learning motivation.

2 System Implementation

2.1 Digital Learning Playground

Digital Learning Playground (DLP) is a theatrical stage with a robot. According to the concept of theatrical stage, we want to create an environment in the classroom that teachers and students can join contextual learning activities and have much more enjoyment. As Figure 1 shows, our digital learning playground has several components: two projectors, PC, IR (infrared ray) module and the robot. The vertical screen presents a situated scene and relevant information about learning content such as background story and tasked events; the horizontal screen serves as a stage for learning performance. PC and IR module are used for connecting each component and control reaction when each event occurs. And then, we use a robot (LEGO MINDSTROMS NXT 2.0 and other LEGO elements and sensors.) be a learning partner to substitute students to perform tasks on the horizontal screen. This robot as a physical character can create involvement and pleasure through the learning process.

Fig. 1. Device setting of DLP

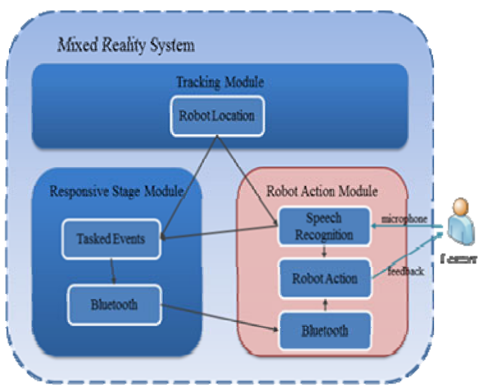

Fig. 2. System architecture of DLP

2.2 Task-Based Learning in Digital Learning Playground

Giving a task to learners can engage learners in using language pragmatically rather than displaying language. Tasks can motivate meaningful practice in learning. The learners can experience what they have learned that related to the world through the process of task completion.

We choose "preposition of space" and "color" for English learning materials, and choose Hide-and-seek, a well-known children's game for designing tasks in task-based learning process. These tasks will be involved into our situated scenario for students to realize and practice prepositions and colors in digital learning playground.

First, the teacher will play a short film about the background story, says there is a Naughty Monkey, Kiwi. This monkey likes to play Hide-and-seek with the robot, at the same time, the screen shows the tasks and the learning partner, the robot, and then the teacher will help students to realize four colored boxes (pink, purple, brown, and gray) and three locations in each box (in, beside, and behind) which are places and locations that Kiwi may hide.

During the task, Students are divided into two groups: Hiding group and Seeking group. The hiding group gives verbal commands to the platform, used for controlling where the monkeys hide in. For example, saying "Three monkeys are behind the pink box." Then the vertical screen will show an animation of the monkey behind the pink box to make students impressive for each command. The seeking group is going to find all the monkeys with robot in limited time. They use verbal commands to the robot by the knowledge just learned to control the robot go to one of the box, and then guess the monkeys' hiding location. The robot is a learning partner for helping students to achieve the task. In the learning process, they use the target knowledge as a tool to help them to complete the assigned task.

Figure 2 shows the system architecture of digital learning playground. There are three modules in digital learning playground, and communicate each other by socket. The Responsive Stage module demonstrates corresponsive sound, background, and virtual effects that determined by signal receiving from Tracking module and send signals to Robot Action module for the robot's motions and actions.

2.3 Role of Robot Companion in Digital Learning Playground

According to our concept about the digital learning playground, the robot is a learning partner in learning process. Therefore, we design several movements and emotional reactions by LEGO's components. The robot can give responses to students with sound effects and simple movements. We assume that the robot's humanize behavior can engage students and promote their immersion and learning motivation.

Table 1. Robot Performance

Act Design	Emotions	Sound effects and (robot behavior)	Students' performance
Task Instructions	Exciting	Let's get all the monkeys.	
		I'm ready!	

Table 1. (*Continued*)

Affective Support in Tasks	encouragement	Oops, try again.	
	praise	Good job! Excellent! (Circling)	
Knowledge-applied Trigger for Learning State	feeling unassisted	I'm lost, please help me. (Turning wrist)	giving unclear command or late response
	tired	I'm tired. Can you help me?	lack of enthusiasm
	sadness	Help me. Come on.	lack of enthusiasm
Humanoid Emotions	satisfied	I'm satisfied. (hiccup)	receiving no response
	sleepy	(snoring)	
	hungry	I'm hungry.	

3 Experiment and Discussion

3.1 Researching Design and Hypothesis

The experiment was held in a classroom with requiring devices. The purpose of the study was to investigate the stage with partner robot can achieve better learning effectiveness and participation. To this end, the hypotheses through this research were:

1. Adding a robot partner with emotions in learning can facilitate learning motivation, engagement (higher participation), and pleasure.
2. Adding a robot companion in a task-based setting can fortify learning effectiveness.

To assess the assumptions, we used questionnaires to collect users' experiential data and formative feedback and measured learning effectiveness by scores of the post-test.

3.2 Procedure

The experiment site was in Hua-duo Science & Language Cram School, Taoyuan, Taiwan. The participants were 60 elementary school third to sixth graders. Each student needed to take a pre-test and post-test before and after the main activity. The pre-test was operated to understand prerequisite conditions of the students. After completing the pre-test, the participants were randomly divided into the control group and the experimental group, 30 students per group. The experimental group learned target knowledge by interacting with the robot on DLP. To assess the assumptions 1, we had experimental group experience tasks with the robot with emotions and without emotions. The main learning activity lasted 40 minutes. In the first twenty minutes, the robot had emotions and responses according to students' feedback and command. The last twenty minutes, the robot only received command and walked to the assigned locations. Afterwards, a questionnaire was conducted to evaluate learning experience in use of the system. To assess assumption 2 regarding to learning effectiveness, the control group took an ordinary English class with a teacher. In the learning process, the teacher teaches target knowledge by using a story and picture cards. The story the teacher used is, "A color of his own", which connects the topic of learning contents. Additionally, we also videotaped the whole learning process to gain the observational data.

3.3 Results and Findings

Our resulted data includes users' perceptions of the robot that was designed for facilitating motivation, engagement, involvement and pleasure in learning process. We adapt five-point Likert Scale for rating in the questionnaire. With regard to users' achievement assessment, we measure the learning effectiveness by the post-test which assesses how well they have learned by filling words in the phrases.

The Robot as a Learning Partner

The questionnaire was administered about users' perception of learning experience through the system. The evaluated factors are: experience, motivation, participation and pleasure. These aspects intend to determine whether the emotional robot can create more interactive, enjoyment and comprehensible learning environment.

Firstly, the awareness of the interaction between the robot and the users reached to 80%. 90% showed their preference learning with a robot over sitting in the classroom.73.3% felt that interacting with robot makes them take great effort to find more monkeys. As to adding pleasure in learning, 76.7% were strongly agreeable that learning with the robot is pleasing.

Table 2. Users' learning behaviors and intentions regarding the robot partner

Statement	Degree(%)				
	SA	A	UN	D	CD
Experience					
I prefer having a robot that has emotional reactions and interact with me in my learning.	80	16.7	3.3	0	0
Motivation					
I prefer learning with the robot over sitting in the class.	66.7	23.3	6.7	3.3	0
I look forward to attending courses with robots.	80	6.7	10	3.3	0
Participation					
I want to complete the task with the robot very much.	73.3	16.7	6.7	3.3	0
If the robot would interact with me, for example: says hello, encourage, etc., it will be very attractive to me, so that I will take great effort to find more monkeys.	73.3	26.7	0	0	0

Table 2. (*Continued*)

If the robot has reaction, it makes me want to complete the task much more. For example: when the robot said tired, I will repeat words aloud to allow the robot to restore the vitality.	76.7	20	3.3	0	0
Pleasure					
Compared with the robot lacked of responses and mobility, learning with the robot had emotion and reaction is more interesting and enjoyable.	93.3	6.7	0	0	0
SA: Strongly Agree; A: Agree; UN: Undecided; D: Disagree; CD: Completely Disagree					

Results of Learning Effectiveness

We would like to know whether adding a robot in a task-based setting can increase the knowledge-in-use opportunity. According to the figures in Table 3, 76.7% showed using (reading out) the words in the activity process can help them to remember target knowledge.

Table 3. Users' learning effectiveness regarding the robot partner

Statement	Degree(%)				
	SA	A	UN	D	CD
Robot in Tasks					
In the process, I must repeat the words again and again to guide the robot go to the right direction. For example: Let the robot go to the purple box, I must read the "purple box".	76.7	13.3	6.7	3.3	0
In the process, use (read out) the words can help me remember these words. For example: When I meet Snowman, I should read "gray snowman", to let the robot move toward the direction of the gray box. This helps me remember the words "gray" and "snowman".	76.7	23.3	0	0	0
SA: Strongly Agree; A: Agree; UN: Undecided; D: Disagree; CD: Completely Disagree					

For assessing how much the users learned through the learning playground, comparing to the ordinary teaching. The statistical results of the pre-test and post-test were summarized in Table 4. In order to minimize the influence of the students' prerequisites of the target learning on the experiment, the research treated the pretest as a control variable. According to the result of the pretest, the average score of the experimental group was 43.03, and control group average was 48.18. We did a two-tailed t-test ($p = 0.636$, $p > 0.05$) and found no significant difference, indicating that the prerequisites of two groups were similar.

With regard to the post-test, the average score of the experimental group was 79.05, and control group average was 61.67. The data showed both groups got progress after the main learning activity, and the experimental group got higher scores than the control group. Applying an independent two-sample t-test to the scores, the result can be seen significant differences ($p=0.011$, $p<0.05$). This is to say that learning achievement in the experimental group was higher than the control group.

Table 4. T-test of pre-test and post-test with control and experimental group

Test	Groups	N	Mean	Std.	Two-tail t-test			
					F	*t*	*df*	*Sig.(p)*
Pre-test	Control	30	48.18	24.83	0.227	-0.808	58	0.636
	Experimental	30	43.03	24.57				
Post-test	Control	30	61.67	27.98	2.451	-2.644	58	0.011
	Experimental	30	79.05	22.66				

3.4 Discussion

Through our observation of the experiment, we found the robot played a significant role engaging students. The students have great interest in interacting with the robot with social emotions. Particularly when the robot said "I am hungry", the students worried and urged their teammates to say "eat candy canes" to feed. In one of our experimental days, the robot couldn't work as usual, and then the students were disappointed and impatient through the process.

4 Conclusion

We have seen that students considered the robot as their learning partner and they can interact with the robot with emotions. In addition, we found the robot played an essential role engaging students. Students showed their strong preference learning with the robot.

In future research and implementation, we would like to expand more robots in the stage that students can compete or cooperate with their classmates. With well-designed emotion types and interaction, the robot can be more interesting and humanistic. Students can use more tools to control the robot, i.e. mobile phones, keyboards, etc.

References

1. Бабієць, І.Г.: Montessori Method in Teaching Foreign Language. Наукові записки Національного університету "Острозька академія. Серія Філологічна, Вип. 11, 446–454 (2009)
2. Dewey, J.: Experience and education. Collier Macmillan, New York (1938)
3. Ellis, R.: Task-based Language learning and Teaching. Oxford University Press, UK (2004)
4. Marti, P., Giusti, L., Pollini, A., Rullo, A.: Experiencing the flow: design issues in human-robot interaction. In: Proceedings of Soc-Eusai, Grenoble, France (2005)
5. Billinghurst, M., Kato, H., Poupyrev, I.: The MagicBook: a transitional AR interface. Computers & Graphics 25, 745–753 (2001)

The Human-Like Emotions Recognition Using Mutual Information and Semantic Clues

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Abstract. In this work, we collect the sentences posted in Plurk as our corpus. The emoticons are classified into four types based on Thayer's 2-D Model which is composed of valence (positive/negative emotions) and arousal (the strength of emotions). The system will preprocess the sentence to eliminate the useless information, and then transform it to be the emotion lexicon. Besides, this research analyzes three kinds of semantic clues: negation, transition, and coordinating conjunctions. The final emotion is decided by SVM and the merging algorithm proposed in this work.

Keywords: Emotion Recognition, Semantic Clues, Mutual Information, SVM.

1 Introduction

Emotion provides relative relations of expressions. Language is an instrument for communication and carries with messages. Messages help one interact with others not only through language but also emotion expression such as speech voice, words, facial countenance or body language. The information source determines how they are read and promotes the cooperation between humans and computer.

Emotion Recognition laid special emphasis on facial and verbal study far more than the study on wording. Daily language contains emotional words for both in orals and writings. Some words provide information at that time and represent certain emotion expression. Sentimental words flow out of the emotional dialogue. We can differentiate varied key words of the dialogue to reflect its emotional state.

2 Literature Review

There are four major trends in the research of natural languages. The first trend was a questioning of the rational approach of generalized grammars and semantic rules. With the establishment of language databases and the rise of new methodologies in linguistics, studies of large amounts of texts became possible. One example was Yang et al. [1] which analyzed Yahoo's news with four methods, namely Bigram, Word, Metadate, and Emotion-related Messages to induce seven emotions. They are Happy, Angry, Sad, Surprised, Heart Warmed, Awed and Bored. This study examines

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precisely how the emotions carried in news could be analyzed through computational methods. The second trend is that statistics are more and more commonly applied and many studies look into the possibility of picking up languages through automation technology. One such study was Kudo and Matsumoto [2][3] development of a Base-NP computation that recognizes how common nouns, and a support-vector-machine model(SVM) set up with different parameters could improve the identifiability through voting. The third trend is that as pre-processing and post-processing have become equally important, statistics and generalization have also become highly significant. You and Chen [4] is one of the studies applying mixed methods. In their study the researchers proposed an automatic semantic labeling in accordance with "dependency decision making" and "example-base" among other tools. The data training and example retrieving were based on the semantic laws developed by Sinica Treebank which first divides words, then transforms them into different significant levels in Probabilistic Model. The fourth trend is the increasing importance of word databases. Chen and Hsieh [5] extracted meanings from tree data structures and developed new words, new categories of words, new relevance of words and new grammar through the Word Bigram technique. Thus they built up a new search system for tree data structures, providing users filtered outcomes and a number of outcomes through keyword search or syntax search.

Currently bimodal emotion recognition system and multimodal emotion recognition system are most commonly applied; they have replaced the singular methods of voice detection or facial expression detection. Silva and Ng [6] applied Bayesian Network as their framework for emotion recognition; they combined voice and mouth shapes to detect whether a face was speaking or not. This system improved its precision rate by referring to voices or facial expressions in cases where there were noises or failure to trace facial expressions. There is research adding body language to enhance the precision rate. Caridakis et al. [7] included facial expressions, voices, hand gestures and body movements detected by Eyes Web into the significance levels decided by the Bayesian Classifier to the eight categories of emotions, and the precision rate of such mixed methods is 10% higher than the singular factor detection. Goh [8] used SVM Training Data and Long Word Priority to strengthen the traits of SVM and increase the performance of word dividing. Zhang [9] applied invisible HHMM to identify five-layer words, including primary dividing of names, places and syntactical functions among other means before establishing a complete word dividing system. Asahara et al. [10] also incorporated two computational tools, namely SVM and CRF to enhance the correction rate.

In sum, support vector machines (SVM) [11][12][13], Neural Networks and HMM will be added subsequently to recognize expressions of delight, anger, sorrow, and happiness [14].

Conclusions from the above, (1) Semantics based analyses always apply in certain domains in which emotional regulations and word stocks are presumed. We always need more efforts to redefine new regulations from the previous processing. Some complicated semantics are not inferable and transformable. (2) Emotion Recognition by key words lacks better identification analytics to extract out influence factors of recognition accuracy. From the mentioned literature, we realize emotion recognition by text analysis has been held in high regard lately. For text-based research, there are some generalizations: (1) Research based on statistical method and massive text materials are more and more important utilizing machine learning method or statistics to generate regulations. (2) Both semantics based and statistics based analyses attach great importance to semantic structures. (3) Recognition accuracy can be elevated when the varied research methods are reciprocal.

3 The Research Method

The system mainly consists of five stages: (1) Data pre-processing: transform the raw data to the formats needed by the system, including extracting significant information, term definition, and word segmetation. (2) Mutual Information: combining associate the lexicon with emotions via mutual information, and generate the correlation strength. (3) Semantics structure message: analyzing fundamentals of syntax, then verifying to common sentences to elevate recognition accuracy. (4) Recognition methods: employing SeCeVa (Semantic Clues Emotion Voting Algorithm) and SVM methods for emotion Recognition. (5) Index merging: generate the final emotion results by combining SeCeVa and SVM via the Maximal Accuracy and Minimal Error algorithms. Fig. 1 shows system structure.

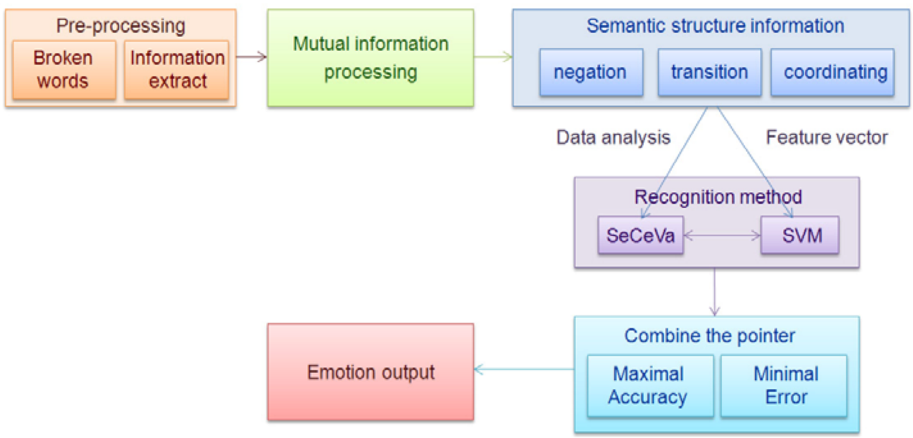

Fig. 1. System Structure

This research aims to filter the redundant information in sentences so that we can obtain the message combination that can represent the emotion contained in the sentence. Besides, we attempt to develop a domain-independent system. Therefore, the Sinica Corpus [15] which contains the complete Mandarin lexicon is employed. There are eight syntactic categories in the Sinica Corpus: Noun (N), Verb (V), Adverb (D), Adjective (A), Preposition (P), Connective (C), Particle (T), and Interjection (I). The 2D emotion model proposed by Thayer [16] simplified these emotional categories. In Thayer's 2D model, "Energy" (Energetic/Calm) and "Stress" (Positive/Negative) are the two dimensions used to segment the emotion space. This 2D model was revised by Yang et al. [17], and is used in this work to simplify these 35 categories.

Therefore, these emotions are divided as four types of emotion: (1) Type-1 Emotion: positive and strong emotion, (2) Type-2 Emotion: positive and weak emotion, (3) Type-3 emotion: negative and strong emotion, and (4) Type-4 emotion: negative and weak emotion. Previous section mentions that we need to indicate relations between terms and emotions after singling out significant terms. We use Mutual Information (MI) [18] as one of the emotion recognition methods. Mutual Information MI(x,y) is defined as: "the collocation strength to measure the association between the two random variables P(x) and P(y)", as shown in equation (1).

$$\mathrm{MI}(x,y) = P(x,y)\log\frac{P(x,y)}{P(x)P(y)} = P(x,y)\log\frac{\frac{\mathrm{Count}(x,y)}{N}}{\frac{\mathrm{Count}(x)}{N}\times\frac{\mathrm{Count}(y)}{N}} \tag{1}$$

According to the Emotion Lexicon developed by Yang et al. [17], this research puts two variables from MI into the formula to calculate the association between emotion and word. After deleting the Stop word (Ex: "??", "very" etc.), we convert it into the MI with emotion-word (we call that Emotional MI; EMI). Show as equation 2.

$$\mathrm{EMI}(e,e_w) = P(e,e_w)\log\frac{P(e,e_w)}{P(e)P(e_w)} = P(e,e_w)\log\frac{\frac{\mathrm{Count}(e,e_w)}{N}}{\frac{\mathrm{Count}(e)}{N}\times\frac{\mathrm{Count}(e_w)}{N}} \tag{2}$$

When we calculate the association ability between two variables with MI, the variables are usually the calculation of single-value variable and another one's. Because of the specialty of Chinese grammar, it would have different meaning comparatively in daily writing or talking in terms of the different collocation with words [19]. And it will affect the expression of emotion indirectly. Take a verb "play" for example; it would be classified into the negative statement. But after collocating with different noun, there're different emotions because of different meaning. We get the emotion information according to this concept, and then further develop a phrase-based PEMI, which is calculated by collocating with emotion. The phrases are the collocation of nouns with predicates. It's an emotion word with V-N series combination and non-V-N series combination. Besides, the definition of phrasal structure is: "The distance between two words is zero in the same sentence." It means that "playing basketball" will be the word. Instead, "Have played basketball" won't. And other words will follow the principle of EMI. And we have an equation 3 for PEMI:

$$\mathrm{PEMI}(e,p_b) = P(e,p_b)\log\frac{P(e,p_b)}{P(e)P(p_b)} = P(e,p_b)\log\frac{\frac{\mathrm{Count}(e,p_b)}{N}}{\frac{\mathrm{Count}(e)}{N}\times\frac{\mathrm{Count}(p_b)}{N}} \tag{3}$$

If the process wants to get into the next step, it must recognize the words correctly in the sentence. So we adopt Sinica Corpus version 3.1, which contains five million terms text corpus with tags. Every sentence is separate by every single word and tagged with categories labeling. And we try our best to averagely distribute the collection of corpus to different theme and syntax. The system has the selective function of recognizing new words and adding tag to the word. For example, "The weather is very find today", It will show that "The weather (Na) is very (Dfa) find (VH) today

(Nd)" through Part-of-Speech tagging. Then start the PEMI transformation after tagging. Below is the algorithm of transforming process:

Step1: Input every sentence (i=1~n) to separate them.
Step2: Exclude not so necessary word of non-nominal and non-predicate.
Step3: Combination provided with V-N condition.
Step4: Turn every single word and emotion into PEMI.

And we get three different categorical information, keyword, emotion No. and PEMI. Every keyword collocating different emotion No. would have different PEMI. In other words, every single word could correspond to a lot of emotions. Take "playing basketball" for example, it could have different PEMI with emotion1, 2, 3 or 4. Then store the completive information in the dictionary. So we could find the information if we want to make emotion determination afterwards.

This research adopts a method from study [17][20] and concludes the emotion. Because we add negative, disjunctive, and conjunctive three meanings of structure information, so we could take language's handling in the account. So we ameliorate Method_3 to be SeCeVa (Semantic Clues Emotion Voting Algorithm). The algorithm is shown in Table 1:

Table 1. SeCeVa process

```
1.   If S is a input sentence through pre-processing and the word segmentation
     automatically
2.   for (Each sentence)
3.    for (By individual analysis of each word after word segmentation)
4.        if (Words belong to semantic transition) {
5.          Cleaning all of previous record data
6.                  }
7.        else if (Words do not belong to connective semantic) {
8.          if (Words belong to keyword in lexicon) {
9.            Recording keyword, emotion No. and PEMI
10.         }
11.         if (Words belong to negative semantic) {
12.           Recording number of negative semantic,
              if the number is singular, transform the emotion
13.         }
14.       }
15.       else if (Words belong to connective semantic) {
16.           Recording complexity of structure
17.         Detect recording votes of emotion No. of keyword currently
     and calculation
18.         if (Votes of emotion No. is the same) {
19.           Extract the highest PEMI of votes in the same emotion No.
20.         }
21.         if (Negative semantic is singular) {
22.           transform emotion
23.         else
```

Table 1. (*Continued*)

```
        not transform
      }
    }
Extract data after recording
The same method to determine the emotion
if (There is a connective semantic) {
  The structure of simple emotions as the final emotion No.
}
```

4 Conclusion and Discussion

In this work, we develop a flexible emotion recognition system. That is, the system can accept the new corpus for re-computing, and generate extended keywords that make the emotion lexicon more useful. We collect the Plurk corpus containing emoticons, and divide these emoticons into four categories according to Thayer's 2-D Model. Moreover, we employ the mutual information to calculate the association between words and emotions. We design the SeCeVa emotion recognition mechanism, and combine it with SVM by two kinds of merging algorithm: Minimal Error and Maximal Accuracy Methods. The major contribution of this paper is attempting to implement an emotion recognition mechanism by combining mutual information and Support Vector Machine. Besides, in this work we build up an emotion lexicon by analyzing social websites such as blog and microblog. Moreover, besides the linear text information, this study takes the structural semantic clues into considerations. We hope this paper could contribute to those who are interested in applying affecting computing techniques in improving the interaction design or emotional intelligence in machine interfaces.

This study implements an emotion recognition mechanism by integrating mutual information and Support Vector Machine. An emotion lexicon is also constructed by analyzing social websites such as blogs and microblogs. In addition to linear text information, this study also considers structural semantic clues. Results of this study significantly contribute to efforts to enhance the interaction design or emotional intelligence in machine interfaces by using affecting computing approaches.

References

1. Yang, C., Kevin, Lin H. Y., Chen, H. H.: Writer Meets Reader: Emotion Analysis of Social Media from both the Writer's and Reader's Perspectives. In: Proceedings of Web Intelligence and Intelligent Agent Technologies, pp. 287–290 (2009)
2. Taku, K., Yuji, M.: Use of Support Vector Learning for Chunk Identification. In: Proceedings of Computational Natural Language Learning, pp. 142–144 (2000)
3. Taku, K., Yuji, M.: Chunking with Support Vector Machine. In: Proceedings of North American Chapter of the Association for Computational Linguistics, pp. 192–199 (2001)
4. You, J.M., Chen, K.J.: Automatic Semantic Role Assignment for a Tree Structure. In: Proceedings of SIGHAN Workshop (2004)

5. Chen, K.J., Hsieh, Y.M.: Chinese Treebanks and Grammar Extraction. In: Proceedings of the International Joint Conference on Natural Language, pp. 560–565 (2004)
6. Silva, L.C.D., Ng, P.C.: Bimodal emotion recognition. In: Proceedings of the International Conference on Automatic Face & Gesture Recognition, Grenoble, France, pp. 332–335 (2000)
7. Caridakis, G., Castellano, G., Kessous, L., Raouzaiou, A., Malatesta, L., Asteriadis, S., Karpouzis, K.: Multimodal emotion recognition from expressive faces, body gestures and speech. In: Proceedings of the Artificial Intelligence Applications and Innovations, pp. 375–388 (2007)
8. Goh, C.L., Asahara, M., Matsumoto, Y.: Chinese Word Segmentation by Classification of Characters. International Journal of Computational Linguistics and Chinese Language Processing 10(3), 381–396 (2005)
9. Zhang, H.P., Yu, H.K., Xiong, D.Y., Liu, Q.: HHMM-based Chinese Lexical Analyzer ICTCLAS. In: Proceedings of the Second SIGHAN Workshop on Chinese Language Processing, pp. 187–187 (2003)
10. Asahara, M., Fukuoka, K., Azuma, A., Goh, C.L., Watanabe, Y., Matsumoto, Y., Tsuzuki, T.: Combination of Machine Learning Methods for Optimum Chinese Word Segmentation. In: Proceedings of Fourth SIGHAN Workshop on Chinese Language Processing, pp. 134–137 (2005)
11. Hearst, M.A.: Support Vector Machine. IEEE Intelligent Systems, 18–28 (1997)
12. Christianini, N., Taylor, J.S.: An Introduction to Support Vector Machines, Cambridge (2000)
13. Nguyen, T., Bass, I., Li, M., Sethi, I.K.: Investigation of Combining SVM and Decision Tree for Emotion Classification. In: Proceedings of IEEE International Symposium on Multimedia (2005)
14. Mihalcea, R., Liu, H.: A corpus-based approach to finding happiness. In: Proceedings of AAAI Spring Symposium on Computational Approaches to Analysing Weblogs, Menlo Park, Calif, pp. 139–144 (2006)
15. Huang, C., Chen, K., Chang, L., Hsu, H.: An Introduction to Academia Sinica Balanced Corpus. In: Proceedings of the 18th Computational Linguistics and Speech Processing, pp. 81–99 (1995)
16. Thayer, R.E.: The Biopsychology of Mood and Arousal. Oxford University Press, Oxford (1989)
17. Yang, C., Lin, K.H.Y., Chen, H.H.: Building Emotion Lexicon from Weblog Corpora. In: Proceedings of 45th Annual Meeting of Association for Computational Linguistics, Prague, Czech Republic, pp.133–136 (2007)
18. Manning, C.D., Schütze, H.: Foundations of Statistical Natural Language Processing. MIT Press, Cambridge (1999)
19. Ahrens, K.: The meaning of double object construction in Chinese. In: Proceedings of the Sixth North American Conference on Chinese Linguistics, pp. 1–14 (1994)
20. Xue, N.: Chinese Word Segmentation as Character Tagging. Proceedings of the International Journal of Computational Linguistics and Chinese, 29–48 (2003)

Paradigm Shift in Education with the Use of e-Portfolio: Showcases of e-Portfolio at Work at the Various Levels of Education – Introduction and Showcase I: K-12 e-Portfolio Involving All Stakeholders

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Abstract. The purpose of this workshop is two-fold: (i) to share with the workshop participants the basic concept of what e-Portfolio is from the viewpoints of students as well as their guardians, professors, and the school boards. Here the dissemination of e-Portfolio in education is the key. While introducing various aspects of this powerful educational tool, showcases are given so that the participants familiarize themselves with what e-Portfolio can do in education. (ii) to discuss the potential of e-Portfolio as the drive to cause a paradigm shift in the entire education ranging from K-12 through the graduate school.

Keywords: e-Portfolio, Oracle Student Learning (OSL), K-12, Kansai University, MUSE Campus, stakeholder.

1 Introduction

The main goal of this workshop is to disseminate the power of e-Portfolio in order to cause a paradigm shift in the entire educational system involving K-12 through graduate school. This workshop is just a small step forward toward such a goal. It consists of prominent showcases to demonstrate that e-Portfolio can trigger a paradigm shift in education. While looking at the showcases of e-Portfolio from K-12 through university or graduate school, we will see that problems that we are facing in the current education may be remedied or solved from the perspective of e-Portfolio.

It cannot be denied that the wave of e-Learning has brought us to the situation where individual courses must be well-structured with learning objectives as well as the clear evaluation measures described in syllabi. Indeed, the levels of ICT literacy for students as well as faculty have been improved. The students now have better command of the computer and better understanding of the course objectives and the evaluation procedures of the courses that they are enrolling.

However, it seems that we have been focusing on the quality control of individual courses too much. As a result, individual courses are autonomous of themselves and the students as well as the faculty are lost in the woods of the education system by

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looking at courses separately instead of looking at the entire curriculum. Now that the quality of courses is of good quality, we need to unite these courses together to map the curriculum with a bigger picture.

1.1 e-Portfolio Way

The approach that we have employed here takes the entire educational region as its domain as shown in Fig. 1 below. By setting the ultimate mission of the school as producing new societal members to fit the needs of the society where the school is based, all stakeholders involving the school will work together to educate future members of the society.

In this approach, a Learning Management System in e-Learning is no longer a course-based management system to manage the course contents, the syllabus, course objectives, daily learning activities, and evaluation measures. It is rather a part of a curriculum mapping or management system, which steers the future direction of the entire school.

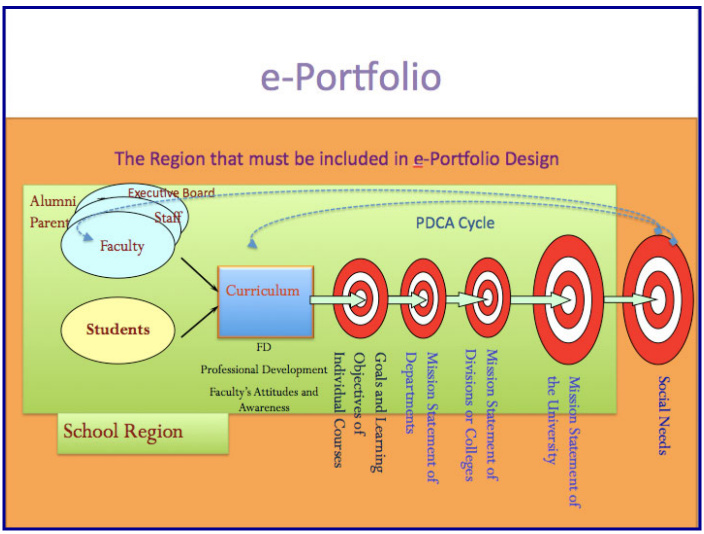

Fig. 1. The region of e-Portfolio: School must develop the curriculum to meet the needs of the society, involving all stakeholders. The ultimate goal of the school is to give birth to future members of the society to elevate the quality of the society.

The design of e-Portfolio for a school begins by setting up the mission for the school. Based on the needs of the society, the school decides how to make the young generation ready for the society through education. In order to set the mission of the school, the school must have clear educational goals to produce new members of the society based on the profound idea of producing ideal people for the nation. Thus, the school must provide students with interactivity in learning to promote human growth in a constructive way. As the students learn, the records of growth of individual students as well as the evaluation of learning are archived in e-Portfolio in order for all stakeholders to share.

In realizing the vision reflected in the mission statement, the evaluation system for e-Portfolio must clearly evaluate the learning activities and the records of the human growth in academia from multiple dimensions. For example, at the lower level, the records are archived of learning processes in the activities described in the list of learning objectives for the courses laid out in the curriculum. In addition, the results of the evaluations are archived. And at a higher level, the records of the growth in a school year, the psychological and societal growth, and evaluation records are archived.

Furthermore, even at a higher level, e-Portfolio archives all records of students from the admission to the graduation, or even the students' entire life. In other words, all the students' life-long records are archived in the e-Portfolio. The e-Portfolio must bear the responsibility of sharing the students' records of growth with their guardians and other stakeholders. The life-long records of the processes of growth for all students as well as the records of evaluation are analyzed even at a higher level to offer predicted "life-to-be" for the currently enrolled students. This type of e-Portfolio will show the students how the life will be with a similar life design in 10 years later, 20 years later, 30 years later, or even 40 years later, making reference to their predecessors' footprints in life.

2 Kansai University e-Portfolio System

Kansai University was established in 1886 and has a history of over 120 years. It consists of 13 colleges and the graduate school with the student population of over 300,000. Kansai University includes five campuses, three senior high schools, three junior high schools, one elementary school, and one kindergarten.

The ultimate goal of the Kansai University e-Portfolio is to archive all students' information including the learning results, the evaluation records, and the meta data scattered in various servers on campus into one integrated e-Portfolio database server. See Fig. 2.

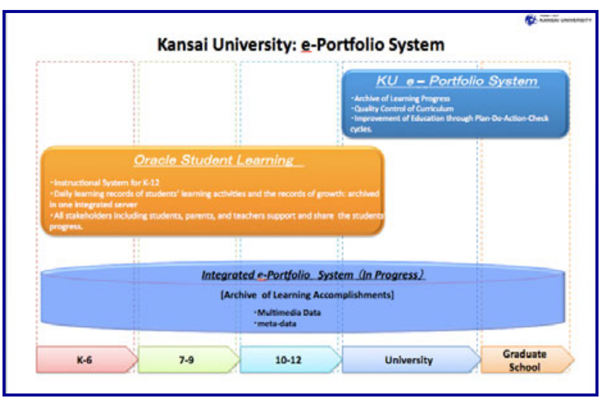

Fig. 2. The current situation of Kansai University e-Portfolio System

2.1 KU e-Portfolio System

KU e-Portfolio System archives and manages students' learning activities and their records through the Plan-Do-Check-Action cycle (henceforth, the P-D-C-A cycle). See Fig. 3. Each student first enters his/her learning goal for enrolled courses and lays out the learning plan. Based on them, the instructor gives advise as well as feedback for improvement.

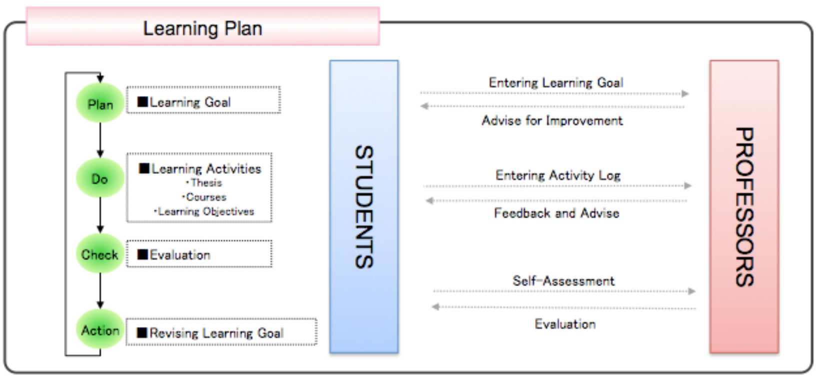

Fig. 3. The Learning Cycle of Kansai University e-Portfolio System

This process continues until both agree with the intended level of achievement. Throughout the course, the student enters logs for learning activities and accomplishments, to which the instructor returns feedback and advice for encouragement. At the end of the semester, the student self-assesses his/her progress, compared with the goal that was set at the beginning of the semester. The results of the self-assessment are again turned in for comments for improvement. In this way, the student's level of motivation for improvement is maintained throughout the semester with the constant care and attention by the instructor. In here all information is kept in the e-Portfolio system as the record for intellectual growth.

The four years of the university life is the most important period for the student. The student enters the university as a child after graduating from a high school. However, in four years, he/she will become an adult and will become a member of a society upon graduation. The mission and its vision of the university will play an important role in producing a new member of the society so that he/she can contribute to the society. This idea is best realized in a unified way with the use of e-Portfolio.

2.2 K-12 e-Portfolio System

K-12 e-Portfolio System is also designed reflecting the mission and its vision for the entire Kansai University. Its purpose is to foster learning for K-12 level students with the support of all stakeholders including students' parents as well as all teachers in the school. With the use of e-Portfolio, Kansai University now can offer consistent education from K-12 to the graduate school. Kansai University is the first university to implement such e-Portfolio in Japan.

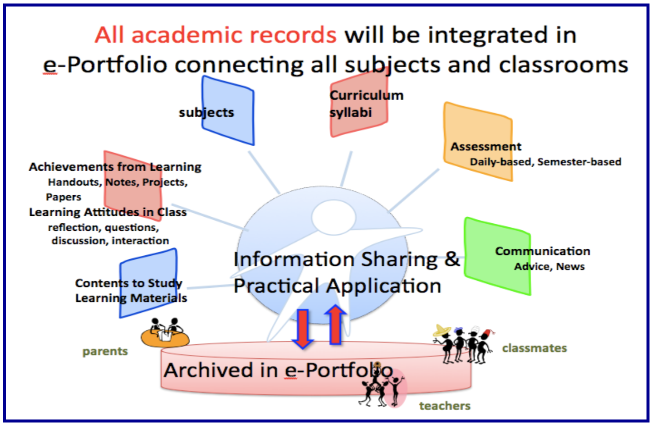

Fig. 4. K-12 e-Portfolio System

Due to the nature of the K-12 education, Kansai University has employed Oracle's Oracle Student Learning (henceforth, OSL), which is based on achievements or tasks at each grade level. Because the Learning Object Metadata to be implemented in the curriculum are already specified by the NICER web site, the K-12 teachers' tasks have been developing the learning contents and rubrics based on the Learning Object Metadata. In OSL, each student's achievement levels for all academic tasks as well as reports for growth are archived to share with the students' parents as well as the teachers.

3 Conclusion

This part of the workshop dealt with an introduction of e-Portfolio. We have discussed possibilities of cause a paradigm shift in education with the use of e-Portfolio. Showcase I dealt with the integrated e-Portfolio ranging from K-12 through the graduate school.

Collaboration and Communication Using e-Portfolio among Junior-High/High School Students from Japan, Taiwan, and the United Kingdom

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Abstract. Among many ways of utilizing e-Portfolio in the field of education, one of the unique cases was to use it as a vehicle to support collaborative projects and facilitate communication between those in distant locations. In an example of Connecting Classrooms East Asia (CCEA) initiated by the British Council Japan in 2008-2009, the combination of two key functions, an e-Portfolio and an online bulletin board, enabled junior-high and junior-high/high school students from Japan, Taiwan, and the United Kingdom to not only hold meaningful discussions, but also learn about and understand each other better. As the students grew to know each other through an interactive e-Portfolio and online bulletin board, they became more active in participating in discussions and the amount of interaction among them increased even further. The paper concludes that the original goal set by the British Council Japan to nurture global citizens through this project was achieved utilizing this online platform.

Keywords: e-Portfolio, Cloud-based Application, International Collaboration, Online Bulletin Board, British Council, Japan, Taiwan, the U.K.

1 Introduction

One of the unique ways of using e-Portfolio was seen in the international collaboration project, Connecting Classroom East Asia (CCEA), initiated by the British Council Japan in 2008-2009. The project originally aimed at improving the international awareness of junior-high/high school students throughout Asia and Europe. The projects of this kind had historically been conducted by gathering the students physically in one location from all over the world for a specific period of time, and facilitating the communication and interaction among them in a classroom setting and/or a group work format. After the internet became widely available in early 2000s, several efforts had been made to create the similar settings virtually, for instance, by creating the online mailing list for students from several different countries and facilitating the communication among them via e-mail, without much success.

The British Council Japan did in fact try to follow the similar path for the CCEA project: creating an online bulletin board in its website, assigning IDs for the participating junior-high/high school students, and letting them communicate online. However, the project only succeeded after the project team implemented a cloud-based

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application, dedicated for the project, which contained not only an online bulletin board for discussion and communication but also an e-Portfolio function where each student could accumulate his/her profile information, short research papers, and presentation materials.

This paper introduces how the project team utilized the cloud-based application with an e-Portfolio function and succeeded in facilitating the interactions among students, in a virtual setting, in different locations and with different cultural backgrounds. First, Section 2 briefly describes the CCEA project itself, focusing on its goal, structure, and implementation process. Section 3 then explains the cloud-based application implemented for the project, and describes how it was used in the project. Finally, we will conclude the paper by sharing some of the outcomes of the CCEA project in Section 4.

2 Project Overview

The CCEA project was kicked off when the British Council Japan approached The Education Institute for Private Schools in Japan for participation in June 2008. The goal of the project was "to build sustainable school partnerships, which broaden the international views of young people and educate young people as global citizens," and the Council tried to achieve it by virtually connecting students of private junior-high/high schools in Japan, Taiwan, and the United Kingdom. After the selection processes, five private junior-high/high schools in Japan were selected for the project, and were invited to communicate with students from Taipei City in Taiwan and Belfast in the U.K.

The project was officially kicked off with Taiwan, Japan, UK Contact Seminar on October 13-15, 2008, and the discussion topics were selected for participating students to conduct research on and discuss. Eventually, the participating students were divided into 8 groups based on the discussion topics that each of them had picked to join. Table 1 incudes all the eight discussion topics as well as some of the examples of sub-topics which students discussed in each group:

Table 1. Discussion topics and examples of sub-topics at CCEA 2009

1. Change of our Life Style
   - *The Progress of Social Activity of Women*
   - *Educational Change*
2. Space
   - *Should we cut money for space exploration?*
3. Water
   - *What is water crisis?*
   - *What can we do NOW for water?*
4. Human Rights
   - *Canada: A Barrier Free Nation*
   - *Afghanistan: A Country Struggling to Develop*
5. Poverty
   - *Poverty of children*
   - *Social problems caused by poverty*

Table 1. (*Continued*)

6. Biodiversity
   - *Type of biodiversity*
   - *Biodiversity of Species*
   - *Treaty for preserving biodiversity*
7. Counseling
   - *Parents' influence over children*
   - *Ways to communication*
8. Energy & Environment
   - *Self-sufficiency ratio in the energy supply of Japan*
   - *Measure with nuclear power generation*

3 Virtual Communication Platform Using e-Portfolio

The project team decided to implement the cloud-based application, *manaba folio*[1], in February 2009 in order to facilitate the communication as well as information sharing among students from different schools and different countries, without them meeting face-to-face. *manaba folio* included two key functions suitable for the CCEA project: an e-Portfolio function and an online bulletin board function.

The e-Portfolio function, shown in Fig. 1, provided each student with his/her own data-space. Students were able to accumulate profile information, short research papers, presentation materials, and any other information that they wanted to save. Thus, by accessing the application, students could check and reflect on their own previous work at any time, in anywhere. It was also equipped with a function which enabled students to share their own portfolios with other participants. With this function, students were able to search and look at other students' portfolios, learn about them, and inquire about what they had been studying.

Another key function, an online bulletin board, shown in Fig. 2, was used as the communication platform where any student could post comments on. Any student could either initiate a series of discussion on a specific topic or respond to peers' comments. In the CCEA project, each of the eight groups was provided with a separate bulletin board, providing students with a method to communicate and collaborate within their group.

The combination of these two key functions, the e-Portfolio and the online bulletin board, fitted well with the CCEA project. Within the discussion group, an individual student or the small team conducted researched on sub-topics, put together a short paper, and saved in their respective e-Portfolio. Other students in the same discussion group could easily access the student's paper accumulated in his/her e-Portfolio, and initiate a discussion on a specific topic using the online bulletin board. After the discussion within the group, the student responsible for the sub-topic could either modify the original paper and save in his/her e-Portfolio, or simply entered discussion notes

[1] *manaba folio* is a cloud-based e-Portfolio system, developed and managed by ASAHI Net, Inc. in Tokyo. It is unique in that it integrates e-Portfolio system with key functions of Learning Management System, including an online bulletin board function.

directly in his/her e-Portfolio. By taking turns, all the participants in the same discussion group were not only able to learn about and discuss a variety of sub-topics, but also able to learn their peers' personalities and values, successfully building a sense of community. An understanding of the peers' background further encouraged them to participate in discussions and the project itself.

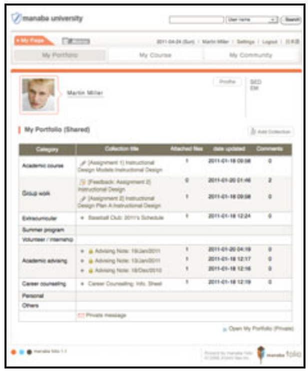

Fig. 1. Sample screenshot of the e-Portfolio

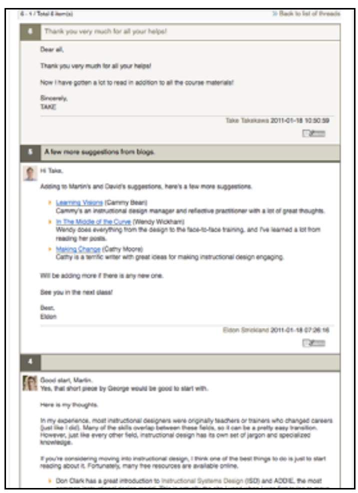

Fig. 2. Sample screenshot of the online bulletin board

4 Results

In order to evaluate the project, we analyzed the statistics gathered on the use of *manaba folio*, and some final comments from Akiko Tokumaru, the student leader of the CCEA project 2009.

Over the course of the project from March 2009 till November 2009, as the students learned more about each other through the interaction took place in the e-Portfolio system and the online bulletin board, the participants became more and more active in joining discussions and communicating more with each other. The usage statistics of *manaba folio* had provided us with some indications on it. As seen in Fig.3, the total number of posts made on the bulletin board of *manaba folio* increased from less than 10 in June, to around 50 over the summer, and eventually to over 180 in November. In the same way, the total number of page view went up from 3,000 in July and August to 16,000 in November. As Akiko Tokumaru, the student leader of the CCEA project 2009, commented in the final report, CCEA 2009 Activity Log, the participating students learned that "communication is important in order to know about and understand each other no matter which country we are from or what language we speak."

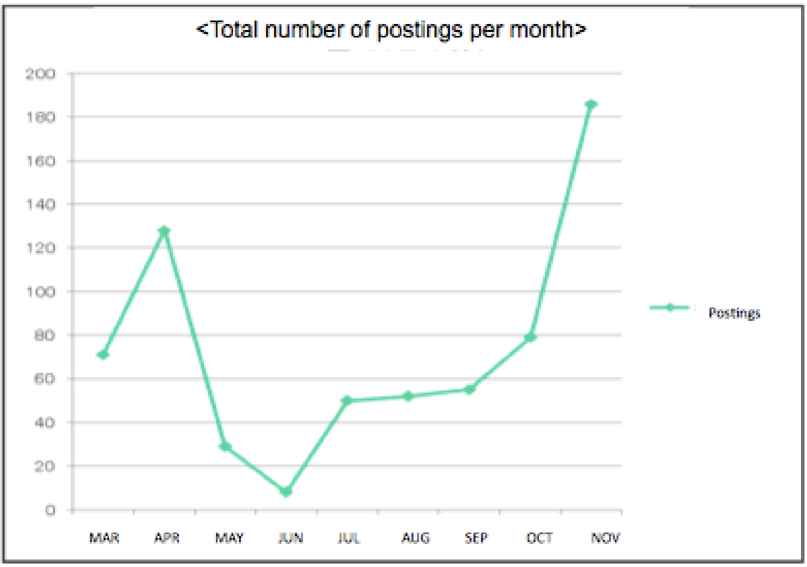

Fig. 3. Total number of posts made on the online bulletin board during CCEA project in 2009

As for the original goal set by the British Council Japan to "broaden the international views of young people and educate young people as global citizens," again, the comment from Akiko Tokumaru indicated the success of this project; "The most important thing in making relationships with friends from other countries is just to have fun communicating in our own expressing way. We are all together on the same planet. So let's not be prepossessed with our own country. We are Global Citizens."

References

1. Yukari Ueno, Y., Ryosuke, M., Atsuna, M., Naoko: How to become a Global Citizen – CCEA 2009 Activity Log Tomorrow's World, Tokyo (2010)
2. Kumazawa, T.: CCEA 2010 Activity Log Tomorrow's World, Tokyo (2011)

Use of e-Portfolio in Effective Career Advising: Case of Ritsumeikan University

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Abstract. This paper discusses the effectiveness of e-Portfolio systems in improving the quality of career advising at the university level, using the case of the Department of Electrical & Electronic Engineering at Ristumeikan University (Japan). e-Portfolio was mainly used to store information about students that was collected through online surveys and for students to reflect on their academic work as well as non-academic activities. It also tracked students' motivation and factors that affected it. Faculty advising was enriched through the promotion of student independence, self-reflection, and proactive participation in school and non-school work, which collectively improved post-graduate career planning strategies.

Keywords: e-Portfolio, Career Advising, Student-centered Learning, Independent Learner, Higher Education, Japan.

1 Introduction

Ritsumeikan University is a private university with three campuses located in Kinugasa, Suzaku, and Biwako Kusatsu in the Kansai area. The university was established in 1900 with the mission of promoting a peaceful and democratic society. Ritsumeikan University is widely considered to be a top-tier comprehensive private university, with a student body of approximately 36,000 (as of 2011) in 13 undergraduate departments, two research institutes, and 16 graduate level programs. The Department of Electrical & Electronic Engineering belongs to the College of Science and Engineering, and enrolls approximately 100 undergraduate students per class with 11 affiliated faculty members.

Although the university attracts highly accomplished students, the Dean of the College of Science and Engineering had been interested in reforming the academic organization of the department. In particular, there were some concerns over their students' ability to acquire basic academic skills prior to their specialization in specific fields of study. Another issue was how to identify students who struggled to fulfill graduation requirements or were at risk of dropping out. Lastly, the department sought ways to promote "student-centered learning" by nurturing greater self-motivation. In other words, the department wanted to create an academic structure and advisory system that supported student independence, instilled responsibility for

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their own learning, and promoted strategic thinking about their coursework and post-graduate career.

2 Advising Program and the Use of Career Charts

The Department of Electrical & Electronic Engineering has traditionally institutionalized advisory support from faculty for freshman and sophomores. There was one professor for every 10 undergraduate students, and discussion topics ranged from academic to non-academic issues depending on student needs. The faculty used a system named “Career Charts” in order to supplement this advisory program.

Career Charts were a list of questions prepared by the department’s career center to keep track of their students’ academic progress and achievements, as well as any personal life issues that students wanted to share. Career Charts were paper-based and were distributed to students annually. Students were asked to fill them out before meetings with their advisors.

While Career Charts were a useful way to collect information, they also had numerous limitations that the department wanted to overcome. First, they did not allow advisors or students to review and reflect on their past work and track record. The actual questionnaire—despite including a large number of questions—needed to be revamped to collect meaningful data about the students’ college experiences. Moreover, Career Charts did not allow advisors to provide customized feedback to each student in a timely fashion, since the survey was only conducted annually. As a result, the usage rate of Career Charts was low and their impact on the quality of advising was minimal.

3 Implementation of “Career Karte”[1]

In order to resolve these problems, some faculty advisors at the Department of Electrical & Electronic Engineering decided to test “Career Karte”, an online portfolio which enables students to store reports and surveys conducted by advisors, review their academic progress, and reflect on their campus life.

3.1 Objective

The faculty’s goal was to promote independent, balanced learning skills. To that end, the purpose of Career Karte was to encourage students to 1) objectively evaluate their performance by reviewing accumulated information on their college career, 2) self-identify any issues or red flags, and 3) learn how to solve problems proactively. Career Karte was designed to promote student independence by having them review their track record regularly and take ownership of their academic work and non-academic activities. The accessibility of these resources would facilitate self-reflection, and thus enable students to better plan for their careers after graduation.

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[1] “Karte” is a German word for card, map, or ticket. In Japan, the word “Karte” is often used in the medical field. Medical doctors and dentists keep records of visits and treatments in each patient’s Karte to accumulate individualized histories of health conditions and procedures.

3.2 Utilizing e-Portfolio as Career Karte

Faculty advisors selected *manaba folio*[2] as a tool to build Career Karte. *manaba folio* offered the following functions that suited this trial to implement Career Karte at Ritsumeikan University. First, it let students build their own portfolio by adding and editing their profile and accumulate papers or notes they wrote. Secondly, advisors were able to conduct online surveys to students and automatically store the responses in each student's portfolio. Thirdly, advisors were able to attach and accumulate notes on each student in respective portfolio, without sharing the content with the student.

Led by several faculty advisors, students were first asked to provide information on both academic and non-academic activities. This included 1) courses enrolled and completed, as well as periodic self-assessments during the semester, 2) questionnaires regarding academics, campus life, and extracurricular activities, 3) resources for career design, such as self-analysis of objectives and achievements, records of participation in alumni speaker series, and reports submitted to conferences and seminars, 4) records of extracurricular activities such as sports teams and volunteer work, 5) information on what led them to attend Ritsumeikan University and choose their subjects of study, and lastly, 6) any information gathered from reflection exercises conducted every semester. Information stored in each student's Career Karte could be accessed by faculty advisors.

Second, students were asked to keep their profiles updated regularly. This included a self-introduction and information on their place of birth, address, language skills, certifications, hobbies, special skills, current interests, career goals, role models, and affiliated clubs and societies.

Third, advisors conducted periodic surveys using the survey function embedded in the e-Portfolio system in order to track student experiences. Responses were sent back directly to advisors and were automatically stored in students' portfolios chronologically. The frequency of such surveys varied, but the findings provided rich, individualized information to advisors. The survey topics included the following:

- Motivation to study, participate in club activities, and take on part-time jobs (monthly)
- Objectives in college life (beginning of first year)
- Academic objectives (beginning of semester)
- Levels of preparation for exams (every semester)
- Thoughts after taking exams (every semester)
- Thoughts after receiving grades (every semester)

By answering these surveys, which were stored in each student's portfolio database, students were able to accumulate information on their basic academic achievements, specialized skills, thinking skills, relationships with others, ability to observe oneself, academic motivation, career planning, and anything related to their campus life.

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[2] *manaba folio* is a cloud-based e-Portfolio system, developed and managed by ASAHI Net, Inc. in Tokyo. It is unique in that it integrates e-Portfolio system with key functions of Learning Management System.

Lastly, student portfolios provided a space for advisors to keep advisory notes on each student and discuss any related issues. These notes were not visible to the students themselves, but were accessible by other advisors. These memos helped advisors to share information on particular students and enabled the provision of seamless, holistic advisory service from multiple perspectives.

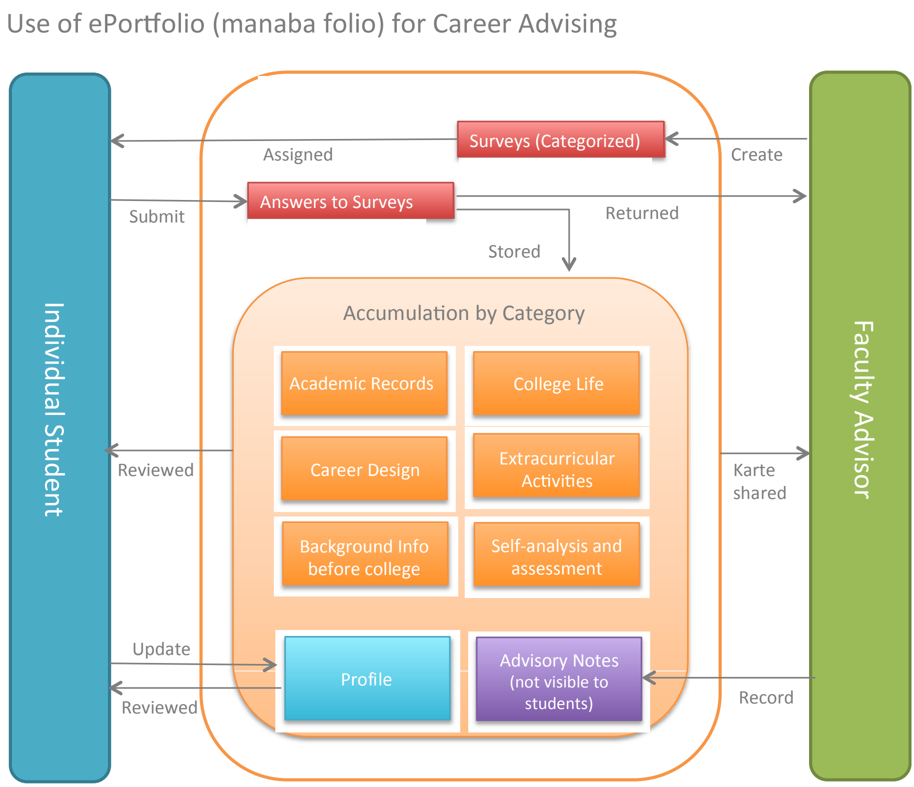

Fig.1. Use of ePortfolio (manaba folio) for Career Advising

4 Results

The faculty advisors found Career Karte to be highly effective in meeting their initial objectives. The use of Career Karte and online surveys enabled the analysis of student motivation and factors that influenced student morale. It became a vital resource for both students, in reflecting on their university life, and for advisors, in identifying specific issues that students faced. Importantly, Career Karte encouraged advisors to reach out proactively to students who needed additional help. Accumulated information on students' academic and campus lives, their motivation (or lack thereof), and past advisory notes enabled faculty to discuss a wide range of issues during their meetings with students. The advisors were even able to track how students' motivation levels shifted over time and pinpoint the factors that affected any changes.

The key factors that aided the successful implementation of Career Karte at Ritsumeikan University were the following:

- An e-Portfolio system that offered numerous functions which enabled advisors to easily create online surveys and automatically store the resulting data in each student's portfolio
- Both open-ended and concrete questions that students could answer easily and succinctly
- Alignment of the timing of surveys with academic classes or seminars to achieve a higher response rate
- Chronological accumulation and presentation of information and data
- e-Portfolio functions that allowed advisors to store and share notes with each other (not accessible by students)

5 Thoughts for Future

The e-Portfolio-based advisory program at Ritsumeikan University can be further improved by reevaluating a few components. The timing and frequency of surveys should be better integrated with classes and seminars to attract more attention and incentivize students to respond. Faculty advisors should also spend more time analyzing their data both quantitatively and qualitatively. Lastly, advisors should interview select students to investigate how the implementation of Career Karte has impacted student experiences from their viewpoint.

Reference

1. Takayama, S.: Presentation "Implementation and Performance of Career Karte after One Year" prepared for "Seminar on Leading Cases of Using Portfolio and LMS – Track record and Educational Impact of manaba" (2011)

Portfolio Intelligence System at Graduate School Level

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Abstract. Graduate education in professional school is highly expected to offer professional courses for the-state-of-art knowledge and skills of fast developing fields. Because of the demand-supply gap of high professionals who can teach in school, we proposed and developed course management procedures based on portfolio system, KIT Portfolio Intelligence System, when we started a new program, Graduated Program in Intellectual Creation System in 2004. KIT Portfolio Intelligence System is described in details in the paper. Several years practice of the system at our graduate program and evaluation made by students used in the course suggests effectiveness in developing professional skills in short term.

Keywords: Process oriented Education, Competency model on demand, Portfolio Intelligence, Action Learning, Carrier Development.

1 Introduction

The use of portfolio in education has a long history starting from progressive education by J. Dewey. In 1950s there was the movement of essentialism in which discipline-centered curriculum was promoted. Major field where portfolio is applied has been curricula and assessment of development of children at lower levels of education. Recently portfolio evaluation procedure in academia, "Academic Portfolio", is proposed by P. Seldin and J. E. Miller. In this presentation we focus on the portfolio education system and practices in graduate and professional school.

It is well-known that there is a huge demand-supply gap in professional education, especially in fast developing fields of business as well as science and technology. The cause of this gap is desperate shortage of teaching staffs in the fields. There exist many professionals in business or R&D front of industry sectors. They have no time to teach in school. One way to solve the problem is to provide an effective support mechanism for them to teach in school.

In the fast developing fields, various disciplines are combined with each other and knowledge and skills need to be frequently updated. This implies the module-based education fits to professional education, in which various modules given by teachers with different disciplines are integrated to one course. The process of the experimental learning that refers to Kolb model (Experimental Learning Model) is also used with the experience, the report and the reflection journal in course works and extracurricular activities.

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KIT (Kanazawa Institute of Technology) is well-known in Japan to be aggressive to reform and refine its educational program. In 2004 KIT started a new program, Graduated Program in Intellectual Creation System, which provides course management procedures based on portfolio education system. To support this program we developed 'KIT Portfolio Intelligence System.' This system takes into account both classroom grades and extracurricular activities in the student evaluation. Individual interviews by professors enable mutual verification of their learning processes and results. The curricula of the course are module-based and adaptive to the student's final goal. The system makes possible systematic procedures for evaluating whole course activities step by step using competency models and the improvement (PDCA) cycles.

In graduate programs final evaluation are usually based on theses, i.e., the final results of students' accomplishment. This is traditionally the case in Japan. The KIT Portfolio Intelligence, in contrast, focuses on quality evaluation processes that correspond to our professional education goal, in which we highly evaluate the process of understanding and gaining knowledge. Education based on the KIT Portfolio Intelligence is found out quite effective for both students and educators. The KIT Portfolio Intelligence has the following features:

- Graduate Student
  - Overall objective evaluations of students, including both their course works and extracurricular activities,
  - Important information is obtained to confirm and recognize the contents of knowledge mastered.
- Educational institution
  - Processes of graduate students' understanding can be visualized.
  - Achievement to the educational goal of graduate program can be clarified.

The KIT Portfolio Intelligence allows students not only to engage fully in research activities for one year but also to obtain such information as systematizing process evaluation by acquiring business practice knowledge, sharing knowledge, and synthesizing knowledge.

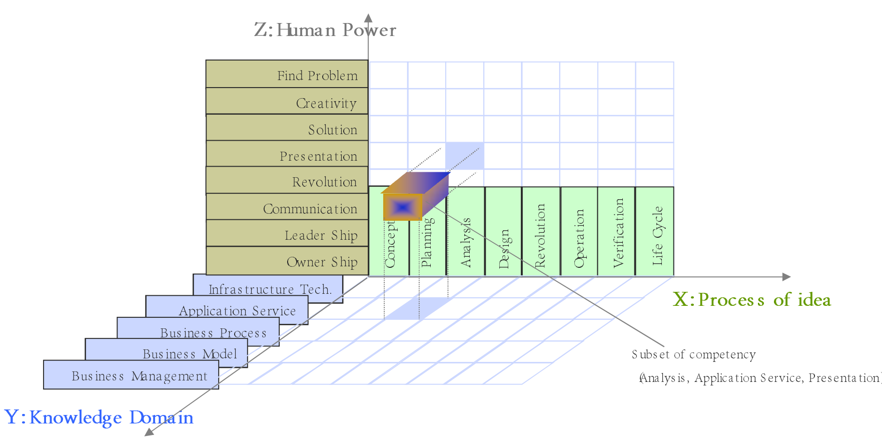

Fig. 1. Competency model on demand

2 Competency Model on Demand

The graduate program, i.e., Program in Intellectual Creation System, has a basic plan of Cultivation for Human Resource Development (HRD). Skill items to cultivate for HRD have been selected on the basis of education policy of the major.

- Power to create intellectual content
- Power to apply an idea to real world
- Power to manage and protect intellectual contents

HRD trains students to obtain fundamental "Power" not only ready to use in work but also as "core-competence" in life-long working and living skills.

Actual procedures of HRD in our program are as follows: At first, graduate students evaluate themselves to know the current level of "Powers" with EQ (Emotional Intelligence Quotient) test. Then, they select a set of the competency items from three domains, "Human power", "Knowledge domain", and "Process of idea" in order to fit the combination of them for their target in the graduate school (Figure.1). Through the procedures student targets are going to be clarified, and the competency registration model is to be constructed. Subset of competency shown in Figure 1 represents integrated feature of three items in different axis's. The strength and weakness of each student are easily recognized by using the combination of subsets during the self-analysis procedure. It also helps students to set their target of study.

3 Portfolio Intelligence File

In this section, we briefly explain the way to compose portfolio intelligence file in our course. Graduate students attend to their master's seminars, research activities, and electives in which there are four phases, Motivation, Plan, Do, and Check, to form a cycle ("Grow-Up Cycle") of the flow ("MPDC") as shown in Figure 2. The graduate students write their summary that describes the knowledge domain, the process of idea, and the human power. The ability to evaluate and reflect on study results is quite important because it enables to evolve at any time. The reflection in wider range during the practice of elective sometimes comes across a motivation of research activities. The portfolio summary is filled up as a result of this Grow Up cycle. The research paper in also written in parallel. As for the portfolio intelligence file, it is the evidence of study in the postgraduate course at the same time though it is his or her individual artifact. Figure 3 summarizes the study flow using the portfolio intelligence file described above.

To maintain these methods, it is important to put on the portfolio desk. The portfolio desk is composed of some professors and some staffs. It's available at any time as a chat channel for the graduate student's portfolio making.

In addition, the portfolio education seminar is executed by portfolio desk for the graduate student over several-time a year. Moreover, the class questionnaires are collected, they are analyzed, and the portfolio system is improved by some request from graduate students and professors.

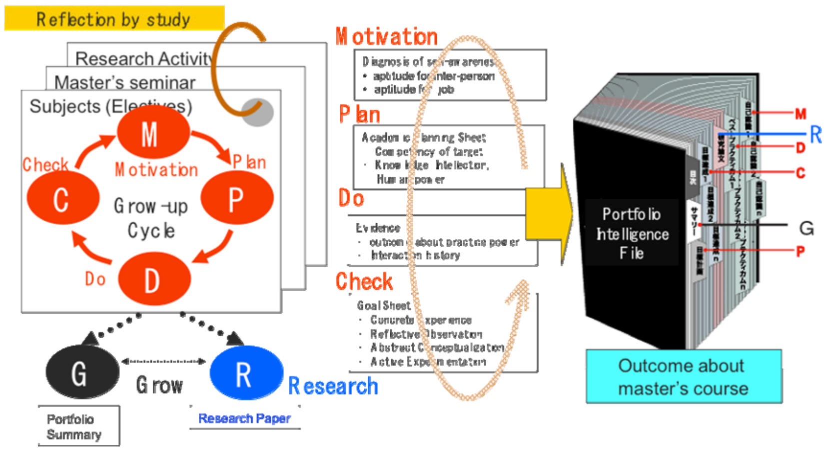

Fig. 2. Portfolio Intelligence File

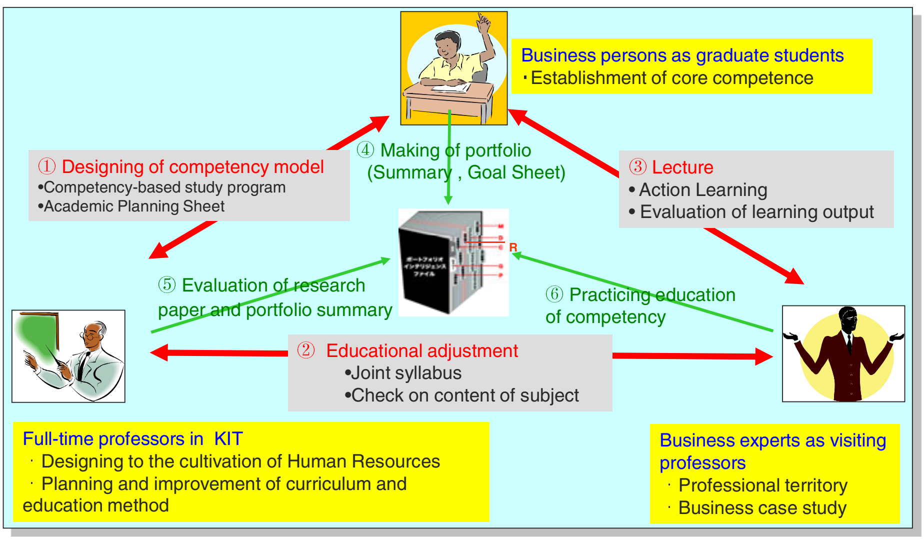

Fig. 3. Relation between portfolio education and learning environment

4 Action Learning Process

In our course, modular-based education has been adopted. In addition, students are guided by the information clearly described in syllabuses in which "Educational methodology", "Material", and "Environment" are described. Processes of the experimental learning that refers to Kolb model are developed with the experience and the report during lectures. Here we describe the model used in our system:

1 CE (Concrete Experience)

The competency model that students seek during the course of the experimental learning is going to be described clearly, and the evidences are also described. Concretely, subjective outcomes are filed by writing about the following points.

2 RO(Reflective Observation)

The content of the experimental learning (CE) is going to be considered and understood from other people's views. Then student describes the results after the reconsideration. Concretely, an objective outcome obtained after the reconsideration of others' stand point is written about the following points.

3 AC(Abstract Conceptualization)

The reconsidered result (RO) has to be proven through an academic article and research. Objective ideas, abstracted ideas, and generalized ideas have to be written and checked. Students are encouraged to grasp essential points. Concretely, ideas derived have to be proven by reconsidering through investigation and research.

4 AE(Active Experimentation)

The results studied at the AC (Abstract Conceptualization) phase of experimental learning are applied to consider the next action planning.

The records of the processes above are archived in the portfolio intelligence file.

5 Conclusion

The educational portfolio system, KIT Portfolio Intelligence System, was elaborated in this presentation. Many professional skills and knowledge, including problem solving, have to be acquired during graduate courses. One good way to improve learning processes more efficient is to strengthen students' self-awareness by feeding back tracing data of skill acquisition processes to them. One of the authors has developed a tool for visualizing an aspect of human cognitive processes. We will utilize this visualizing mechanism in KIT Portfolio Intelligence System in future, which will be expected to encourage students to self-trace their skill improvement, in addition to self-evaluate their skills and knowledge.

References

1. Bruner, J.S.: The process of education. Harvard University Press, Cambridge (1965)
2. Seldin, P., Miller, J.E.: Academic Portfolio. Jossey-Bass, San Francisco (2008)
3. Kolb, D.A.: Experimental Learning. In: Experience as the source of learning and development. Prentice-Hall, New Jersey (1984)

4. Nakazawa, M., Matsuo, K., Kato, K., Izumiya, R.: Process Oriented Education System based on Portfolio Intelligence Can Offer Finely-textured Education in Graduation Course. Japanese Society for Engineering Education 1(W-05), 32–35 (2008)
5. Marquardt, J.: Optimizing the Power of Action Learning: Solving Problems and Building Leaders in Real Time. Davies-Black Pub. (2004)
6. Kanazawa Institute of Technology: Portfolio Intelligence System (2004), `http://www.kanazawa-it.ac.jp/tokyo/portfolio/` (retrieved on June 15, 2011)

Deployment of Interactive Games in Learning Management Systems on Cloud Environments for Diagnostic Assessments

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Abstract. Game-based assessment has attracted a lot of attention of educators and researchers in recent years. However, how to efficiently integrate and deploy the educational games in an e-learning environment is still an open question. In this study, a novel architecture integrating Learning Management Systems into cloud computing environments is proposed for game-based assessment. A prototype is constructed by using Moodle and Hadoop to conduct preliminary evaluation. In addition, interactive games are designed for diagnostic assessment in Mathematics. Survey results show that the proposed approach is promising for motivating the learners.

Keywords: Interactive games, Learning Management Systems, Cloud computing, Diagnostic assessments.

1 Introduction

With the flourishing development of information technology, e-Learning has grown as an important learning paradigm. To facilitate adaptive and individualized learning, teachers are encouraged to develop adaptive teaching materials for their courses and students. Recently, the Sharable Content Object Reference Model (SCORM) has been widely accepted as a standard of e-Learning for users to share and reuse teaching materials. The computer games with interesting scenarios and attractive multimedia provide a way to motivate students to learn actively. There are several applications of computer games to the learning activities, including simulation platforms, assignments and projects [1].

Applying the game as assessment tools motivates students to participate in tests, and understand the learning achievements with visualized charts or scores. For example, the biology, chemistry, and economics of farm management are simulated in [2], and the Fish Tank [3] simulated the nitrogen cycle in an aquarium. Applying game as assignment [4], [5] can motivate students engaging in the assignments with interesting game scenario and game context, such as the scoring, adventure, and competition

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properties. Applying game creation project [6] can assist students to easily understand the abstract knowledge with interesting game context.

With the promising development of game-based learning environments, there will be a great demand to find desired educational games from repositories in the e-learning environment. In [7] the issues of integration and deployment of educational games in Learning Management Systems are addressed. Game-based learning can be applied to underachiever tutoring, which serves as an alternative approach to instruction. Therefore, a novel method of remedial instruction is proposed to rapidly diagnose misconception and to adaptively teach tutees. At first, volunteer tutors use diagnostic strategies to find out students' misconceptions. Then, they adopt adaptive remedial instruction to teach students. We find that volunteer tutors can solve students' problems quickly using the proposed system.

In this study, a novel architecture integrating Learning Management Systems into cloud computing environments is proposed for game-based assessment. A prototype is constructed by using Moodle and Hadoop to conduct preliminary evaluation. In addition, interactive games are designed for diagnostic assessment in Mathematics. Survey results show that the proposed approach is promising for motivating the learners.

2 Ontology-Based Learning Content Retrieval

An ontology-based framework is proposed to manage and retrieve games as learning objects, as shown in Figure 1. This framework consists of three phases. In the ontology building phase, users' folksonomies are clustered into a hierarchical ontology. An ontology-based global index is then created to facilitate semantic search. Finally, users' queries are interactively verified in the search phase, and desired content is retrieved fast and precisely.

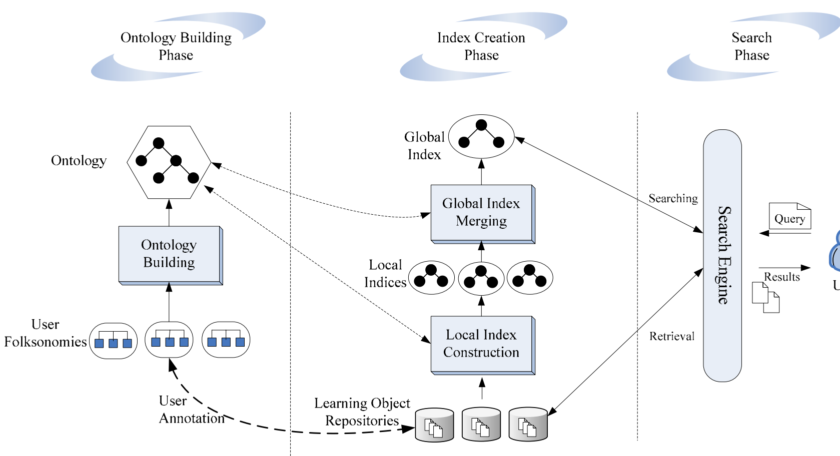

Fig. 1. The framework of ontology-based content management

3 Implementation and Results

In this section the cloud test-bed is introduced, the designed games are presented and the survey results are reported.

3.1 Cloud Test-Bed

Figure 2 shows the proposed cloud computing architecture. The distribution file system was built on HDFS of Hadoop environments [8]. This Hadoop platform can be described as PaaS (Platform as a Service), effectively extending SaaS (Software as Service) to platforms.

The Middleware's purpose is to assign and acquire the best transmission path to distribution file system. This Middleware also collects necessary information, such as bandwidth between server and server, the server utilization rate, and network efficiency. The information is utilized to determine the best solution of downloading allocation jobs.

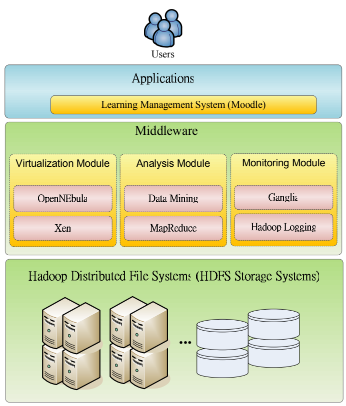

Fig. 2. The architecture of the cloud test-bed

The summary of the nodes and the real-time status of the cloud test-bed acquired by the monitoring tool are shown in Figure 3.

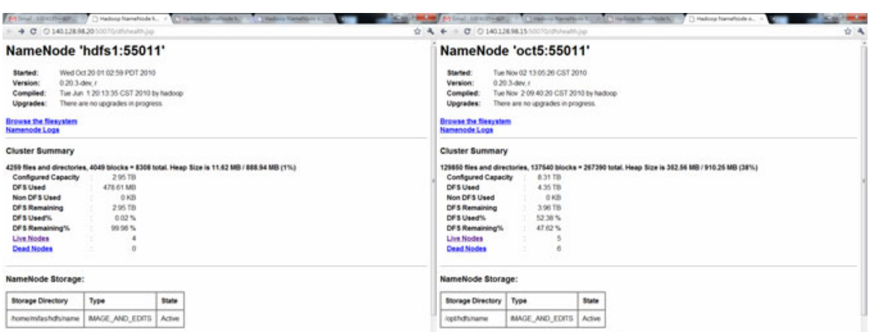

Fig. 3. The node summary of the cloud test-bed

3.2 Interactive Games

Interactive games have been applied to support the teaching of abstract knowledge to promote the learning performance. This study is focused on the scenario of volunteer tutoring, where tutors are not professional educators. When tutors teaching pupils, they need supports from experts, such as learning content and teaching methods. For example, they need to identify students' misconception quickly and then provide suitable remedial instruction. Interactive games serve as good tools to conduct diagnostic assessments. In the proposed approach what tutors need to do is to follow standard procedures to utilize games in the learning management system in the tutoring process.

Figure 4 shows an interactive game for the mathematical unit of "equivalent factors." Students can move the red and blue bars in the game to compare two factors, such as 1/2 and 3/6.

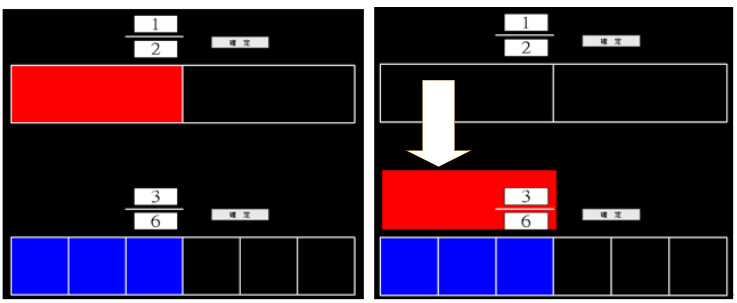

Fig. 4. The first game in the equivalent fraction unit

3.3 Opinions of Students

To collect participants' opinions on this approach, we have conducted an open-ended-question interview with ten tutor participants and ten student participants. The open-ended questions are listed as follows. What is your main problem while teaching/learning mathematics? What do you think of using interactive games as an auxiliary teaching mechanism? Tutors' opinions are summarized as follows.

Certain mathematical concepts are difficult for students to understand. When students cannot fully understand after the instructions, one of the tutors said to students: "Practice more exercises and you will understand it someday." The other tutors said, "Just memorize the formulas." These tutors wanted to help students understand these concepts but they did not know the appropriate teaching methods. Oppositely, other tutors will look for useful teaching materials such as web searching or peer assistance. The tutors stated that the proposed approach can help them retrieve useful and valuable teaching methods.

Students' opinions are summarized below, respectively. Some of the students stated mathematics is abstract and difficult to learn. With the proposed approach tutors try alternative teaching methods to make them understand the meaning of mathematical concepts. Students will not hear such answers as "you will understand it someday" or "just memorize the formulas."

4 Conclusions

This work describes an ontology-based approach to managing interactive games as learning objects on cloud environments. To efficiently retrieve learning content on clouds, our idea is a bottom-up approach to organize local repositories and generate a global index, which is based on an ontology built from user-defined tagging systems, folksonomies. Furthermore, to facilitate rapidly develop individualized interactive games, a wiki-based approach is suggested.

Several issues will be further investigated in the future work. In this paper, the performance issue of location-aware indexing has not been addressed. When the size of the learning object repository grows rapidly, low-level indexing technologies can be adopted to alleviate this issue. Resource sharing and fault tolerance are interesting issues for cloud applications. In recent years, researches on the convergence process of Wiki applications have attracted extensive attention, such as the ontology crystallization problem. These techniques can be applied in the Wiki-based teaching material design process.

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References

1. Weng, J.F., Tseng, S.S., Lee, T.J.: Teaching Boolean Logic through Game Rule Tuning. IEEE Trans. Learning Technologies 3(4), 319–328 (2010)
2. Shang, J., Jong, M.S.Y., Lee, F.L., Lee, J.H.M.: A Pilot Study on Virtual Interactive Student-Oriented Learning Environment. In: Proc. First IEEE Int'l Workshop Digital Game and Intelligent Toy Enhanced Learning (2007)
3. Tan, J., Biswas, G.: Simulation-Based Game Learning Environments: Building and Sustaining a Fish Tank. In: Proc. First IEEE Int'l Workshop Digital Game and Intelligent Toy Enhanced Learning, pp. 73-80 (2007)
4. Sindre, G., Natvig, L., Jahre, M.: Experimental Validation of the Learning Effect for a Pedagogical Game on Computer Fundamentals. IEEE Trans. Education 52(1), 10–18 (2009)
5. Papastergiou, M.: Digital Game-Based Learning in High School Computer Science Education: Impact on Educational Effectiveness and Student Motivation. Computers and Education 52(1), 1–12 (2009)
6. Jiau, H.C., Chen, J.C., Ssu, K.F.: Enhancing Self-Motivation in Learning Programming Using Game-Based Simulation and Metrics. IEEE Trans. Education 52(4), 555–562 (2009)
7. Torrente, J., Moreno-Ger, P., Martínez-Ortiz, I., Fernandez-Manjon, B.: Integration and Deployment of Educational Games in e-Learning Environments: The Learning Object Model Meets Educational Gaming. Educational Technology &Society 12(4), 359–371 (2009)
8. Apache Hadoop Project, `http://hadoop.apache.org/`

A Pilot Study of Interactive Storytelling for Bullying Prevention Education

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Abstract. The bullying prevention education aims to teach students the management of cognition and emotion conflicts. To prevent bullying, the awareness and adult involvement are two key prerequisites. However, the awareness of bullies and victims is the challenging and important issue. In this paper, the Interactive Storytelling is proposed to provide assessment for bullies and victims. Storytelling is usually used in the teaching to motivate students to realize the abstract concepts through the stories. The storytelling is a good approach to situate students in specific scenario for easily providing the assessment and guidance for students to resolve the conflicts. To record the students' storytelling process, the Scratch multimedia editing tool is used as platform to support the storytelling by making animation. To support the assessment, the story template is proposed using knowledge acquisition approach. Firstly, the students are situated in the predefined story background. Next, students can choose one action from several predefined story branches and perform the main character by typing the script and voice recording. Through the acting of roles as bullies or victims, the teacher can realize the students' thinking while in the cognition and emotion conflicts situations. In the experiment, 63 junior high school students were participated in the pilot study. The students were engaged in the digital storytelling and were willing to express their thinking and the digital storytelling can effectively support the awareness the bullying.

Keywords: interactive storytelling, e-learning, bullying prevention education, Scratch, assessment.

1 Introduction

In the last few years, the problems of social or physical bullying led to the increased awareness of bullying prevention education in school. Bullying is a serious matter involving a substantial number of students. In the United States approximately 20% of students report having been bullied [7]. In Taiwan, there are 18.8% have been

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bullied. There are several types of bullying which 77% of cases are intentionally excluded, 60% of cases are verbal assault and 10.5% of cases are physical contact [6]. However, teachers rarely detect bullying, and intervene in only 4% of all incidents [8]. In the last few years, with the serious bullying news events, the problems of social or physical bullying led to the increased awareness of bullying prevention education in school. The bullying prevention education aims to teach students the management of cognition and emotion conflicts. To prevent bullying, the awareness and adult involvement are two key prerequisites [9]. However, the awareness of bullies and victims is the challenging and important issue. Bullying is often tolerated and ignored because students who report bullying believe that nothing will be done.

In this paper, the Interactive Storytelling approach is proposed to assess the bullies and victims. Storytelling is usually used in the teaching to motivate students to realize the abstract concepts through the stories. The storytelling is a good approach to situate students in specific scenario for easily providing the assessment and guidance for students to resolve the conflicts. To record the students' storytelling process, the Scratch multimedia editing tool is used as platform to support the storytelling by making animation.

To support the assessment, the story template is proposed using knowledge acquisition approach. Firstly, the students are situated in the predefined story background. Next, students can choose one action from several predefined story branches and perform the main character by typing the script and voice recording. Through the acting of roles as bullies or victims, the teacher can realize the students' thinking while in the cognition and emotion conflicts situations. In the experiment, 66 junior high school students were participated in the pilot study. The students were engaged in the digital storytelling and were willing to express their thinking. From the questionnaire analysis, the digital storytelling can effectively provide assessment for awareness the bullying.

2 Related Works

The narrative and story of storytelling have been proved to be useful to enhance the students thinking during the education [3]. Storytelling allows students to present the thinking structure and to provide a good way to realize the abstract cognition [4]. To make a storytelling, The Gunning proposed the story map including setting, characters, problem, goal, plot and outcome [1].

Creating the interactive multimedia animation is interesting for students [2]. To improve the learning effectiveness, the Scratch [5] developed by Resnick from MIT Media Lab is used as the storytelling platform based on the simple building block-based interface with low barrier and high expressive power. In the Scratch tool, the children can easily create their own animations and upload them to the Scratch online website to share their animations with other community members.

Based on the constructivism, storytelling by making an animation aim to motivate students participate the learning and engage students in the learning activity. However, the assessment of the unconstrained storytelling is difficult. Therefore, how to design the storytelling assessment methodology that allows students express their thinks with flexibility and remains the understandability is still an important and challenging issue.

3 Interactive Storytelling Assessment

As mentioned above, the assessment of bullying needs to keep the flexibility of storytelling and remains the understandability. To solve the issue, the Interactive Storytelling Assessment is proposed. There are three main processes in the Interactive Storytelling which are situation, reaction and reflection.

Fig. 1. The situation, reaction and reflection processes of interactive storytelling assessment

In the situation process, the stories about different cognition and emotion conflict events are provided as situated condition. The story structure is designed with predefined scenes and characters to show the different characteristics of roles. The students act the selected characters, the bully for example. The animation can motivate the students to immerse in the story. In the reaction process, the branches of decisions with s are provided. Students can select one reaction from storylines such as to beat the victim, to assault the victim, to forgive the victim. Students select the storyline, and they can edit the animation of the character to perform the selected reaction to the situation. Through the reactions selection, the students' characteristic can be shown. In the reflection process, the consequences of their selected reactions are shown. For example, the victim is injured and the bully may be punished by the adults. Next, the second step reflection actions about bullying or forgiving the victim are provided for students to select and perform. The main bullying prevention education is provided in this step. Since students know the consequences of the selected reactions, their reflection actions can show their characteristics.

Through the defined situated animations and branches of storylines, students' storytelling activities are constrained in predefined categories. The three processes design reveals the students' intentions in the storytelling to support the assessment. Students can perform the degree of emotion conflicts through the animations making for each selected actions. To provide the assessment, the Scratch tool is used as the assessment platform. To assist the students making the animation, the poses or actions of the main characters are provided as shown in Figure 2. Students can efficiently create the animations that they want by composition the poses of the main character.

Next, the students can further type in the scripts or record the dialog of the main character to perform their emotion expression using the Scratch tool. Since the sequence of the main animation is predefined and constructed in the story sample, students can rewrite the given animation samples to create their own animation.

Fig. 2. The poses of main character in Scratch

4 Experiment Design

In the experiment, there are 63 junior high school students participated in the interactive storytelling for bullying prevention education. In this pilot study, the experiment aims to evaluate if the Scratch tool is usable for the students to express their thinking to fulfill the assessment requirement. The researchers provide the Scratch tool and predefined sample story content for the students. After the interactive storytelling, the teacher collects and analyzes the students' creations. To further realize the students' thinking, the teacher also asks students to write down the reason of performing the action.

5 Findings and Discussions

After analyzing the students' animations, there are 68% students select the violence, 22% students select the assault and only 10% students select forgive as the reaction to the emotion conflict situation as shown in Figure 3.

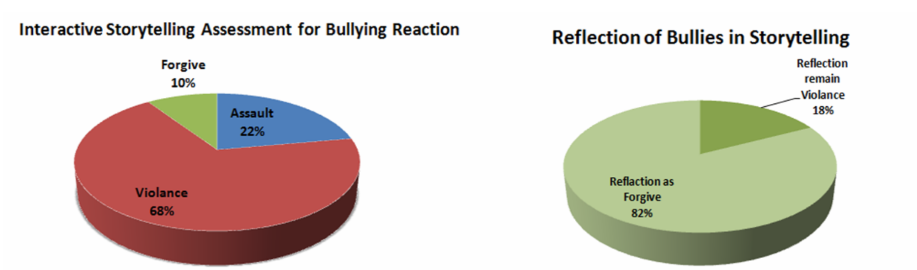

Fig. 3. The pie charts of students' reactions and reflections

Among the 90% of students who choose assaulting or violence in the reaction stage, they can provide their reflection after they know the consequences of their bullying actions in the reflection stage. Their reflection actions show that 82% of students decide to forgive the victims and 18% remain violence actions. It is interesting that most students can forgive the victims in the reflection stage. It shows that if students can manage their emotion and think about the consequences of bullying, then many bullying events can be prevented. The pilot study also found that students engaged in the interactive storytelling assessment and they wanted to express their thinking in the storytelling. It shows a new way to communicate with students to realize the thinking in their minds.

6 Conclusion

The storytelling is a good approach to situate students in specific scenario for easily providing the assessment and guidance for students to resolve the conflicts. To record the students' storytelling process, the Scratch multimedia editing tool is used as platform to support the storytelling by making animation. To support the assessment, the story template is proposed using knowledge acquisition approach. Through the acting of roles as bullies or victims, the teacher can realize the students' thinking while in the cognition and emotion conflicts situations. In the experiment, 63 junior high school students were participated in the pilot study. The students were engaged in the digital storytelling and they were willing to express their thinking. From the questionnaire analysis, the digital storytelling can effectively provide assessment for awareness the bullying.

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References

1. Gunning, T.G.: Creating reading instruction for all children. Allyn & Bacon, Boston (1996)
2. Jiau, H.C., Chen, J.C., Ssu, K.F.: Enhancing Self-Motivation in Learning Programming Using Game-Based Simulation and Metrics. IEEE Transactions on Education (4), 555–562 (2009)
3. Howland, K., Good, J., Robertson, J.: A Learner-Centred Design Approach to Developing a Visual Language for Interactive Storytelling. Department of Informatics (2007)
4. Olenowski, M.: Appeal to Head and Heart:The Integration of Emotional Bonding for Effective Preaching (2000)
5. Resnick, M.: Sowing the Seed for a more Creative Society. In: International Society for Technology in Education (ISTE), pp. 18–22 (2007)
6. The Child Welfare League Foundation, `http://www.children.org.tw/news.php?id=2451`
7. Whitney, I., Smith, P.K.: A survey of the nature and extent of bully/victim problems in junior/middle and secondary schools. Educational Research 35, 3–25 (1993)
8. Elsea, M., Smith, P.K.: The long-term effectiveness of anti-bullying work in primary schools. Educational Research 40, 203–218 (1998)
9. Skiba, R., Fontanini, A.: What Works in Preventing School Violence: The Safe and Responsive Fact Sheet Series, Safe & Responsive Schools Project (2000)

Assessment for Online Small Group Discussion Based on Concept Map Scoring

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Abstract. In problem based learning (PBL), small group discussion is the crucial factor for the effectiveness of the learning process. It is necessary for the discussion to be monitored and guided by the instructor for most e-PBL implementations. The research proposed an assessment method to evaluate the small group discussion without the presence of the instructor during the process of discussion. The assessment is based on the concept map scoring whereat a concept map will be constructed by the system during the discussion and scored by the master concept map. In addition, the proposed method is validated by applying to a college-level database course under e-PBL environment. The results reveal the correspondences with the performances of the groups.

Keywords: problem based learning, concept map scoring, small group discussion, e-PBL.

1 Introduction

Problem based learning (PBL) is a student-centered approach that the designed curricula are appeared as subjects in the context of complex, multifaceted, and realistic problems. Students work in groups to examine the problem situation, and through the discussion students are expected to identify and access the required information leading to the solution of the problem. In PBL, the role of the instructor is to provide scaffolding of the PBL process such as arranging groups, assigning problems, or asking probing questions. Therefore, the learning is commonly conducted in the small group discussion. The crucial factors for the effectiveness of learning process in PBL are how to keep the discussion on the related topic and how the instructor evaluates the discussion content and provides the proper guidelines.

PBL online (E-PBL) is widely developed in decades with the internet innovation technologies. Tools and systems such as POLARIS (Problem-Oriented Learning and RetrIeval System), CoMMIT (Collaborative Multi-Media Instructional Toolkit) [6], PsyWeb[5], and eSTEP [2] are released to facilitate e-PBL. One of the challenges for e-PBL arises from face-to-face environment to virtual environment. The evaluation for the small group discussion in e-PBL becomes a challenging problem due to the difficulties of controlling the discussion order and users' engagement in the virtual environment [3]. Furthermore, researchers have noted that considerable effort has been expended on the development of managed learning environments rather than the

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pedagogy of such development [1]. The cost of training an eligible instructor or assistant for e-PBL is increasing.

To evaluate the participation in small group discussions, the research suggests three indicators of success: degree of participation, interaction and cognitive and content-related posts. The degree of participation can be evaluated by some statistic values (e.g., the number of messages per student in every discussion topic, total number of messages per student, etc). Regarding to interaction and cognitive posts, with the presence of instructor, the evaluation can be performed by observation and different forms of assessments or questionnaires.

This research aims to provide an appropriate assessment on small group discussion. The proposed concept map construction for the discussion content and the scoring method assess the small group discussion for not only the degree of participation but also the interaction and cognition of the learning topics. It also eases the requirement of the presence of instructor during the discussion. An implementation and experiment are applied to validate the proposed method. The promising results show the sound evaluation of the online group discussion.

2 Concept Map Mining and Scoring

The discussion contents of a group discussion can be treated as an 'essay', which is co-written by the students in the group. The main difference between article and discussion is that the group discussion usually contains large amount of non-topic-related content. Therefore, data pre-processing plays an important role of determining the analysis outcome. Building and scoring the concept map of discussion content is one of the solutions to evaluate overall understanding of the discussion topic for the discussion group.

Concept Map Mining

Concept mining is the extraction of concepts from human non-fiction writings. In order to construct the concept map precisely, the first step is to reduce the unprofitable, differentiating meaningful and meaningless sentences. After cleaning up the sentences, the concept map can be constructed during the discussion process. This research first adapted *Sinica TreeBank* [4] to extract concepts from the discussion content of the assigned group. However, *Sinica Treebank* cannot recognize *Nouns* appropriately, especially glossaries like 「主鍵」primary key, 「正規化」normalization, etc. In addition, *Sinica Treebank* cannot recognize English compound nouns. For instance, 「每張表格的primary key」would parsed as NP(NP(NP·*的* (head:NP DM:每張|Head:N:表格)|Head:T:的)|Head:N:primary)|Head:N:key. In this example, 「primary key」cannot be parsed as a single *Noun* or *Noun phase*. Based on the described limitations, *Sinica Treebank* shows incapability of constructing concept map from the online small group discussion content.

Concepts can be represented by a concise word, and concept map consists of concepts. Hence, concept map can be considered as a set of keywords that are interconnected by relations (ref). In general, a word has synonyms. For instances, 「Schema」and「Table」,「Column」and「欄位」. Therefore, the system can expand a well-defined concept map to a set of keywords with synonyms. To extract concept from discussion contents of students, the system uses set of keywords (master concept map) to match concepts extracted from the discussion group. For example, 「不重複的欄位 作為主鍵」(Non-duplicate column as the primary key), this sentence has only one concept : 「欄位」 that appears in the mater concept map shown in Fig. 1. The concept is recognized and added to the discussion concept map for the later construction.

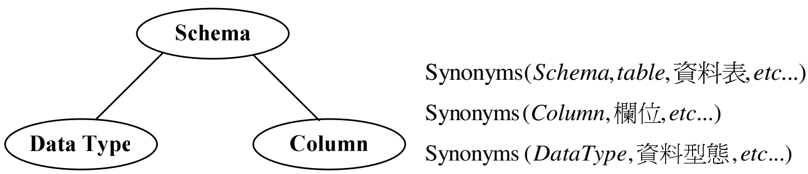

Fig. 1. Concept map construction

Once the concepts in the discussion group have been spotted, the relationships among concepts then can be constructed. In pragmatic, concept relationship mostly occurs in the same turn [10], in other words, these sentences appear in same turn, should describe same theme. Hence, concepts extracted from sentences which appear in same turn should be described same theme.

Because the extracted concepts describe the same theme, these concepts exists relationships that interconnect related concepts. Concept map could be constructed after gathering these concepts from discussion content and relationship between concepts.

Concept Map Scoring

To score the concept map constructed by the small group discussion, this research adapts the relational scoring method from McClure, J.R., & Bell, P.E. [7]. The reliability and validity of the relational scoring method has been verified in McClure, Sonak & Suen [8]. There are three main criteria in the relational scoring method:

1. Link between concepts in master Concept Map
2. Label of relationship indicate possible relationship
3. Direction of arrow indicates a hierarchical relationship

In this research, the first criterion of the relational scoring method is applied to score the discussion concept map comparing to the master concept map. The scoring rules are defined as follows:

If two concepts satisfy the two conditions below, these two concepts scores one point. 1. Concept *A* and *B* are found at discussion concept map and also appear at master concept map. 2. Concept *A* and *B* are both interconnected in discussion concept map and master concept map.

3 Implementation and Experiment Design

We apply the discussion evaluation method to a college-level database course under e-PBL environment. During the course, the instructor first lectures brief knowledge about database. For example, brief introduction of database, usage of DDL(Data Definition Language) and DML(Data Manipulation Language). This course also uses Moodle(http://moodle.org/)[9] as the learning environment. The instructor uploads learning materials like SQL statement samples or slides onto Moodle. Throughout the semester, the instructor formulates questions and asks students to discuss assigned problems in synchronous discussion rooms of Moodle. The implementation for the evaluation of small group discussion is shown on Fig. 2.

The class is divided into six small groups, and each group has five to six students. Students are allowed to form their own group regardless their class performance. Each group is assigned to discuss same topics in Moodle during the semester. There is no limitation for time and length of the discussions. In this experiment, the master concept map for the selected topic is constructed with 35 concepts and 34 links by the instructor. The discussions are carried out without the presence of the instructor. During the discussion, the system records the assessment information for each group including the number of extracted concepts, the number of link, score, time and the number of sentences as shown in Table 1.

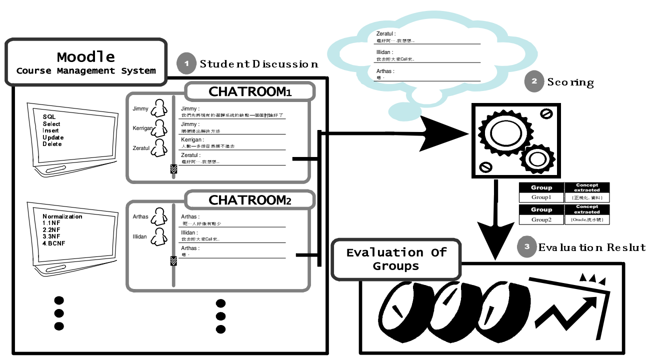

Fig. 2. Implementation of discussion evaluation

Tabel 1.

Group	Concepts	Links	Score	Time(minutes)	Sentences
1	11	4	12	405	655
2	5	0	0	117	651
3	11	1	11	205	914
4	2	1	2	67	111
5	0	0	0	71	219
6	6	1	4	210	404

4 Results and Conclusion

The results show the assessment of the small group discussion based on the three aspects mentioned in the previous section: degree of participation, interaction and cognitive and content-related posts. The time and the number of sentence simple can be used to evaluate degree of participation and interaction. However, as to the cognitive and content-related posts, the constructed concept map and the score well represent the level of understanding for each assigned topic. According to the results, group 1 and 3 show not only high participation and interaction but also high score on cognitive posts.

The results reveal the correspondences with the performances of the groups but are still preliminary. The presence of instructor controls the track and orders in small group discussion for e-PBL. In the future, based on the pre-constructed master concept map, an intelligent agent can be implemented to gently share the load of instructor in group discussion for e-PBL environment.

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References

1. Britain, S., Liber, O.: A framework for the pedagogical evaluation of elearning environments. Report to JISC Technology Applications Programme.218 References (2004), `http://www.cetis.ac.uk/members/pedagogy/files/4thMeet_framework/VLEfullReport`
2. Derry, S.J.: eSTEPas a case of theory-based web course design. In: O'Donnell, A.M., Hmelo-Silver, C.E., Erkens, G. (eds.) Collaborative reasoning, learning and technology, pp. 171–196 (2006)
3. Jacqmot, C., Milgrom, E.: From PBL to e-PBL. In: Barker, P., Rebelsky, S. (eds.) Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications 2002, pp. 1325–1328. AACE, Chesapeake (2002)
4. Huang, C.-R., Chen, K., Chen, F.Y., Chen, K.J., Gao, Z.M., Chen, K.Y.: Sinica Treebank: Design Criteria, Annotation Guidelines, and On-line Interface. In: Proceedings of 2nd Chinese Language Processing Workshop (Held in conjunction with the 38th Annual Meeting of the Association for Computational Linguistics, ACL-2000), Hong Kong, October 7, pp. 29–37 (2000)
5. Koehorst, A., Ronteltap, F., Schmidt, H.G., te Winkel, W.W.R.: Design, Implementation and Evaluation of PsyWeb, a Learning Environment in a Problem Based Learning Curriculum. In: Proceedings of the New Educational Benefits of ICT in Higher Education (2002)
6. Lautenbacher, G.E., Campbell, J.D., Sorrows, B.B., Mahling, D.E.: Supporting collaborative, problem-based learning through information system technology. In: Proceedings on Frontiers in Education, pp. 1252–1256 (1997)
7. McClure, J.R., Bell, P.E.: Effects of an Environmental Education-Related STS Approach Instruction on Cognitive Structures of Preservice Science Teachers. Pennsylvania State Univ., University Park. Coll. of Education (ERIC Document Reproduction Services No. ED 341 582) (1990)
8. McClure, S., Suen: Concept Map Assessment of Classroom Learning:Reliability, Validity, and Logistical Practicality. Journal of Research in Science Teaching 36(4), 475–492 (1999)
9. Moodle official page, `http://moodle.org/`
10. Sacks, H., Schegloff, E.A., Jefferson, G.: A simplest systematic for the organization of turn-taking for conversation. Language 50(4), 696–735 (1974)

Using Game-Based Learning and Interactive Peer Assessment to Improve Career Goals and Objectives for College Students

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Abstract. This article aims to develop game-based learning and interactive peer assessment to improve college students' career goals and objectives. A total of 36 students enrolled the "Sport Guidance and Counseling" course and participated the "Job Hunting" game. Each student completed a "future resume" and played the role-play game to demonstrate their ability to find a job. Peer assessments were completed during the game as in-class activity. Self-critiques and reflections were required to post on the course blog. Participation observation and blog feedback were two major qualitative research methods to collect the data. Constant comparison was utilized to analyze the data with QSR Nvivo7. The results identified that students learned through concrete experience, reflective observation, abstract conceptualization and active experimentation in the interactive peer assessment. The finding showed that game-based learning and interactive peer assessment are viable combinations to motivate colleague students to collaborate and to improve career goals and objectives.

Keywords: game-based learning, interactive peer assessment, sport, physical education.

1 Introduction

Peer assessment is an arrangement for peers who have similar status to evaluate the level, value, worth, quality or successfulness of the learning outcomes of others [1]. Several studies of peer assessment between college students and found that these activities were very various in type and different types of peer assessment would create educational benefits by its different mechanism [2]. Formative and summative peer assessments are used for decision-making in education settings, but if the teach-

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ers or administrator use the information of peers to make a single decision, it can be described as summative assessment [1]. Therefore, interactive peer assessment seems more likely to be formative assessment because the purpose of the assessment is to assist learning [3-7]. Interactive peer assessment is likely to involve intelligently and adaptively questioning, together with increased self-disclosure and assessment of understanding. This assessment help students to find out their misconception and error identification/analysis in the early stage of learning through the process of explaining, simplification, clarification, summarizing, reorganization, and cognitive restructuring and to improve their self-awareness, self-assessment and generalization to new situations [1,8]. Also, it increases learning motivation because it enhances learners' sense of ownership and personal responsibility, greater variety and interest, activity and inter-activity, and improves self-confidence, self-identification and bonding, and empathy with others [1].

Recent research have identified that game-based learning is a viable way to help learners to construct knowledge from ambiguity, trial and error, and to assimilate new knowledge [9-13]. Past studies in game-based learning have focused too much on theoretical aspects of gaming and are lack of empirical evidence to validate its educational meaningfulness [14]. Wang and Chen [14] stated that game-based learning is linked with experiential learning and share the same theory, experiential learning cycle [15]. It uses four stages to describe the learning process in educational environment (Figure 1). Game-based learning provided learners to have opportunity to develop game strategies that include game scenario, matching, challenging, and problem solving and to generate simplification of abstract concepts and facilitate learners in developing transferable skills and knowledge [9,10] [12,13].

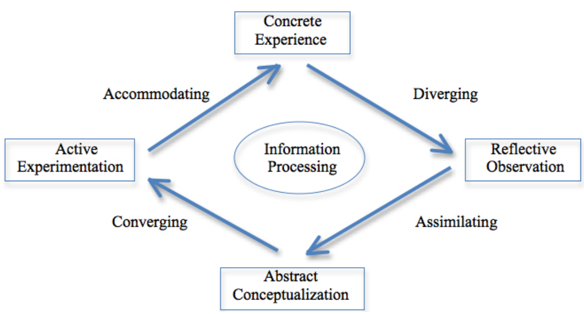

Fig. 1. Four stages of Kolb's experiential learning cycle (Adapted from Wang & Chen [14])

2 Methodology

A total of 36 sophomore college students voluntarily enrolled the "Sport Guidance and Counseling" course and participated the "Job Hunting" game-based testing to assess their career goals and objectives in 2011. Before one week of the "Job Hunting Game-Based Learning", the instructor announced the content of the activity and asked students to prepare a "future resume" for themselves. The future resumes were used to project their career goals and objectives five years later. Students were asked to write down their ideal working experience, certification, academic performance and extracurricular activities on their future resumes for applying jobs.

Each group was requested to develop a name of company, interview question lists, grading score system within 20 minutes. Then, each group started to send one of their member to different groups for 10-minute interview by turns until every member was interviewed. At the end of the game, the instructor asked all groups to select one "most wanted" and one "most unwanted" interviewees. Those groups published their lists on the blackboard and illustrated the reasons of their choices. After the game, the instructor asked students to write feedback on the course blog within three weeks.

Participation observation and blog feedback and interactions were two major qualitative research methods in the data collection. Qualitative data were imported to QSR*Nvivo7 and constant comparison was utilized to analyze the qualitative information [16].

3 Results

Using Kolb's experiential learning cycle as a theoretical framework, the study found that students experienced four stages in the game-based learning process.

3.1 Concrete Experience

Through this game, students were able to acquire concrete experience for their career goals and objectives. One participant shared his feedback with the primary investigator and said, *"It made me nervous so much! I never image that it was such a terrible situation. Five "bosses" stared at me and asked me very sharp questions. I felt myself just like a rabbit in front of a herd of lions…they examined my resume carefully and found out lots of mistakes that I made… It is not only just an assignment, but also a bridge to my dream job…"*

3.2 Reflective Observation

The game also provided a channel for students to observe peers performance. During the interview process, students allowed to see peers' performance when they had similar questions and reflect to themselves. One student who was marked as the "most unwanted" interviewee said, *"Now I knew what my weaknesses are. I saw my classmates' performance and thought of myself. I am just far behind. They wore really formal and what I wore just like a shit! With right dress, they looked professional. Now I know what to do if I have second chance…"*

3.3 Abstract Conceptualization

The game also provided an opportunity for participants to think of the strength and weakness of career goals and objectives. With peers' critiques and questions, students examined their "ideal resume" and found lots of "unreal" goals and objectives. One participant said during the interview process, *"Okay, I knew that some parts of my resume are not realistic, however, they are my goals. Probably, I did write down too much that I can do within five years…Yes, I never think of those before. Thank you so much for reminding me about this."*

3.4 Active Experimentation

After the game, students were requested to write down their feedback on the course blog. Most students not only write down what they have learned but also express what they plan to do. One student wrote down her refection on the course blog, *"Now I know what I have to do now. I should attend classes for public speech, and attend many camps and training to gain more skills and knowledge, to gain volunteer experience, and professional judge and coach certifications!"*

3.5 Interactive Peer Assessment

Facilitating under game-based learning, interactive peer assessment also increased three different levels of feedback in this learning activity.

Corrective feedback with immediacy. *One student said, "I knew that I have to practice my oral and presentation skills. My reaction time is too long, cannot get to the point of those questions…they are all my weaknesses."*

Confirmatory feedback with clarification. *A participant said, "Surprisingly I found that some outstanding classmates in academic performance were selected as "most unwanted" interviewees just because they don't have good presentation skills with self-confidence… It just blow my mind…I must train myself more on that…"*

Suggestive feedback with cognitive restructuring. *One student said, "This interview process is so real. We experienced what we have to face and really saw the "real" world five years later. This interview was not just a process that you show up in person or testing you physically, but also an examination about your mental and social abilities. Those are what I have learned from my interviewers… "*

4 Discussion

A major strength of this study was to provide an empirical evidence for using game-based learning and interactive peer assessment to facilitate a collaborative learning environment for improving learners' career goals and objectives. According to previous study, college students in the department of physical education commonly have difficulty in academic performance and a strong alternative approach to motive their learning. Through the process of participating game-based learning and interactive peer assessment, students in the study perceived benefits from formative peer assessments and practiced the learning process of the experiential learning cycle.

5 Conclusions

The study gives insight on how game-based learning and interactive peer assessment were used to enhance college students to enhance their career goals and objectives. The research findings showed that game-based learning and interactive peer assessment are viable ways to motivate college students to learn intrinsically. Further researches on different learning styles or types of peer assessment are suggested to understand alternative choices in higher education.

References

1. Topping, K.J., Smith, E.F., Swanson, I.I., Elliot, A.A.: Formative Peer Assessment of Academic Writing Between Postgraduate Students. Assessment & Evaluation in Higher Education 25(2), 149–169 (2000)
2. Topping, K.J.: Peer assessment between students in college and university. Review of Educational Research 68(3), 249–267 (1998)
3. Liu, E.Z.F., Chang, Y.F.: Gender differences in usage, satisfaction, self-efficacy, and performance of blogging. Bri J. of Edu. Tech. 41(3), E39–E43 (2010)
4. Liu, E.Z.F., Lin, S.S.J.: Relationship between peer feedback, cognitive and meta-cognitive strategies and achievement in networked peer assessment. Bri J. of Edu. Tech. 38(6), 1122–1125 (2007)
5. Liu, E.Z.F., Lin, S.S.J., Yuan, S.M.: Design of a networked portfolio system. Bri J. of Edu. Tech. 32(4), 493–496 (2001)
6. Liu, E.Z.F., Lin, S.S.J., Chiu, C.H., Yuan, S.M.: Web-based peer review: An effective web-learning strategy with the learner as both adapter and reviewer. IEEE Transactions on Education 44(3), 246–251 (2001)
7. Tseng, S., Weng, J.: Finding trustworthy experts to help problem solving on the programming learning forum. Interactive Learning Environments 18(1), 81–99 (2010)
8. Topping, K.J., Ehly, S.: Peer Assisted Learning. Erlbaum, Mahwah (1998)
9. Adcock, A.: Making digital game-based learning working: An instructional designer's perspective. Library Media Connection 26(5), 56–57 (2008)
10. Gros, B.: Digital games in education: The design of game-based learning environment. Journal of Research on Technology in Education 40(1), 23–38 (2007)
11. Liu, E.Z.F., Lin, C.H.: Developing evaluative indicators for educational computer games. British Journal of Educational Technology 40(1), 174–178 (2009)
12. Pivec, M., Dziabenko, O.: Game-based learning in universities and lifelong learning: 'UniGame: Social skills and knowledge training' game concept. Journal of Universal Computer Science 10(1), 14–26 (2004)
13. van Eck, R.: Six ideas in search of a discipline. In: Shelton, B.E., Wiley, D.A. (eds.) The Design and Use of Simulation Computer Games in Education, Rotterdam, Sense, pp. 31–60 (2007)
14. Wang, L., Chen, M.: The effects of game strategy and preference-matching on flow Experience and programming performance in game-based learning. Innovations in Education & Teaching International 47(1), 39–52 (2010)
15. Kolb, D.A.: Experimental learning. Prentice-Hall, Englewood Cliffs (1984)
16. Strauss, A., Corbin, J.: Basics of qualitative research: Grounded theory procedures and techniques. Sage, London (1990)

Digital Educational Games in Science Learning: A Review of Empirical Research

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Abstract. This study is an initial attempt to review digital educational games in science learning. A total of 8 studies were selected from ISI database for review. A series of content analyses demonstrated that role-playing games are relatively more popular in science educational setting, and most of the games involved a "multiplayer" design. Beside, most of these games were used to be "a learning context or environment" for students' science learning and most of them are designed for high school students. This study further found that most of the digital educational games in these studies were expected to improve student content knowledge, inquiry ability, or motivation. It suggests that inquiry ability should be considered as an important learning objective in future game-based science learning. This study also revealed that the quasi-experimental research method was not commonly used in these studies, and the digital educational games in science learning are not always effective learning tools. Suggestions for further research are discussed in this study.

Keywords: science education, game-based learning, digital educational games.

1 Introduction

In the recent years, more and more educators have paid attention to the potential of using computers games or online games for educational purposes [1]. These computers games or online games are often termed "digital educational games". There are several types of digital educational games, including adventure and role-playing games, business games, board games, combat games, logic games and puzzles, and word games [2], and digital educational games may be designed for single player [3] and multi-players [4].

Games are powerful educational tools if used appropriately [2]. Although game playing is joyful, digital educational games may have various learning objectives when they are designed or used in the classes. In most of the relevant empirical studies, the learning objectives focus on student achievement and their motivation [3]. To achieve learning objectives of a digital educational game [5], pedagogical models (or instructional strategies) play an important role in the success of the integration a digital educational game into classroom [5].

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In the past, many empirical studies have been conducted to examine the effects of digital educational games in school setting, and previous research has revealed controversial findings regarding digital educational games. To help educators and researchers obtain deeper insights into this issue, reviews on the effects of digital educational games may be of much importance. Up to now, several literature reviews on the effects of educational games have been conducted [6][7]. Among these reviews, some focused digital educational games in a specific subject domain, such as health sciences [7]. However, a literature review focusing on the use of educational games in science education is still not available yet. A review on digital educational games in science education may be helpful to improve science educators, instructors and researchers' understanding of digital educational games. Also, it may provide researchers in game-based learning deeper insights into further potential use of digital educational games in science education. Therefore, this study aims to review the use of educational games in science education.

2 Methods

This study was conducted to review the use of educational games in science education. To this end, a series of content analyses was conducted. The Social Sciences Citation Index (SSCI) database was the literature source for this review. In this study, research published in any types of publications other than journal articles, such as in conference proceedings, unpublished dissertations, books or book chapters were not included. To this end, first, the researchers searched the electronic database by using ISLE keywords. To be included, each study should include at least one keyword regarding science, at least one key word regarding education, and at least one keyword related to game. The keywords for science education included *science, biology, chemistry, physics, and geosciences*. The keywords used for the education is *education and educational, while* the keywords used for the game is *game.* The three sets of keywords were combined by using the Boolean logic "AND", and a total of 187 papers were selected. Then, the researchers manually and systematically screened the article titles and abstracts and confirmed that the selecting articles: 1) must be using digital game(s) for learning, 2) should be related to science education, and 3) must provide empirical evidence or evaluation. Finally, 8 papers were identified as the sample pool of this review.

3 Results and Discussions

3.1 Characteristics of the Digital Educational Games

Table 1 showed that the types of digital educational games used in the relevant studies were role-playing games (5 studies) and logic games and puzzles (3 studies), implying that role-playing games are relatively more popular in science educational setting. For science educators, improving student inquiry ability is crucial. Role-playing games can provide authentic learning environments for students to practice inquiry activities. Besides, those games were presented as video games, and thus can provide immersive learning environments for promote student learning engagement in science.

Also, Table 1 revealed that most of the games used in science education involved a multiplayer design. It may due to that collaborative learning have always been highlighted by science instructors and educators. This study also summarized pedagogical roles of the selected games. It was found that most of the digital educational games in science education were used as “a learning environment” (n=5), while some of them was used as “an instructional tool” (n=3), in which the games were only a part of learning activity. In other words, most of these games were used to be “a learning context or environment” for students’ science learning, while the others were only used as “instructional tools” in learning activity.

Table 1. Characteristics of the digital educational games

Characteristics	Categories
Game type	role-playing games (5), logic games and puzzles (3)
Player design	single player (2), multiplayer (3), both (3)
Pedagogical role	a learning environment (5), an instructional tool (3)

3.2 Student Academic Levels and Science Subject Domains for Game-Based Science Learning

Table 2 revealed that, among the eight studies, five were conducted in high school (grade 6 to grade 12), and two were conducted in elementary school (grade 1 to grade 6). Moreover, only one study was conducted in university science. The results above indicates that the effects of digital educational games in high school students’ science learning received relatively more attention from researchers in game-based learning. Further studies are suggested to be conducted in elementary school science and university science settings Moreover, among the 8 studies, four studies were concerned with the use of digital educational games in general science learning; three were related to physics learning; while one focused on the use of digital educational games in biology learning. It seems that still not many digital educational games are used to promote student learning outcomes in a domain-specific science discipline, such as physics and biology. Moreover, it should be noticed that digital educational games concerning with chemical learning and earth science education are not available in the selected studies.

3.3 Research Method, Expected Learning Outcomes, and Results for Game-Based Science Learning

Table 2 also showed that most of the studies were conducted with developmental research or case study research methods (n=5), followed by mixed research method (n=2), quasi-experimental research method (n=2), and quantitative research method (n=1). Vogel et al. (2006) have argued that examine the effects of game-based learning without a control group is problematic. Therefore, it is suggested to use quasi-experimental research method in future research when investigating the effects of the use of digital educational games in improving student science learning.

Moreover, it was also revealed that, in these relevant empirical studies, most of the digital educational games were expected to improve student content knowledge (n=7), followed by inquiry ability (n=3) and motivation (n=2). Student content knowledge and their learning motivation have been largely identified as the expected learning outcomes in the previous literature reviews regarding game-based learning [8]. It should be noticed that student inquiry ability seems to be a special learning objectives in some of these games. In fact, student inquiry ability has always been the most important education goal in science education, and it may not be viewed as a desired learning objective in other subject domain. In other words, when designing digital educational games for science learning and evaluating the effectiveness of these games, we may have to take the specialized educational goals in science education into consideration. To this end, the collaboration among science educators and game designers and researchers in game-based learning will be helpful.

Among the relevant studies, five out of eight revealed positive results, while the other three showed mixed results. It indicates that the digital educational games in science education are not always effective learning tools. The finding above concurs with that in the previous studies [8]. It highlights the importance of integrated frameworks for designing and integration of digital educational games in science classrooms, as advocated by researchers [5]. Further research is suggested to design digital educational games in science learning with the frameworks advocated by researchers [5] and carefully examine the effects of the games with studies designed by quasi-experimental research method.

Table 2. A summarized table for the empirical studies regarding game-based science learning

Study	Dependent variables	Research method	Science domain	Student grade level	Results
Jong et al (2010)	inquiry ability	development & case study	general science	7-12	mixed
Miller et al (2011)	knowledge & attitude	quantitative	general science	7-12	positive
Kim et al (2009)	knowledge	development & case study	physics	7-9	mixed
Li (2010)	knowledge, motivation	mixed method	physics	1-6	positive
Echeverria (2011)	knowledge	case study	physics	9-12	positive
Annetta et al. (2009)	knowledge, engagement	quasi-experimental	biology	7-12	mixed
Barab et al. (2007)	knowledge, inquiry ability	design-based research	general science	1-6	positive
Barab et al. (2009)	knowledge, inquiry ability	mixed method; quasi-experimental	general science	university	positive

4 Conclusion

This study analyzed 8 digital educational games in science learning. The results demonstrated that role-playing games are relatively more popular in science educational setting, and most of the games involved a "multiplayer" design. Beside, most of these games were used to be "a learning context or environment" for students' science learning and most of them are designed for high school students. This study further analyzed the research methods, expected learning outcomes, and results of these selected study. It was found that most of the digital educational games were expected to improve student content knowledge, followed by inquiry ability and motivation. It suggests that inquiry ability should be considered as an important learning objective in game-based science learning. Regarding research method and design, the use of quasi-experimental research method in future research is suggested. This study also reveals that the digital educational games in science learning are not always effective learning tools. This study is an initial attempt to review digital educational games in science learning. The finding derived from this study may provide some insights for those interesting in digital educational games in science learning. Further research is suggested to design digital educational games in science learning with the frameworks advocated by researchers [5]. Also, careful examinations regarding the effects of the games will be suggested. In particular, quasi-experimental research method will be suggested for future research.

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References

1. Paraskeva, F., Mysirlaki, S., Papagianni, A.: Multiplayer online games as educational tools: Facing new challenges in learning. Computers & Education 54, 498–505 (2010)
2. Alessi, S.M., Trollip, S.R.: Multimedia for learning: methods and development, 3rd edn. Allyn & Bacon, Boston (2001)
3. Miller, L.M., Chang, C.I., Wang, S., Beier, M.E., Kisch, Y.: Learning and motivational impacts of a multimedia science game. C & E 57, 1425–1433 (2009)
4. Annetta, L.A., Minogue, J., Holmes, S.Y., Cheng, M.T.: Investigating the impact of video games on high school students' engagement and learning about genetics. Computers & Education 53, 74–85 (2009)
5. Echeverria, A., Garcia-Campo, C., Nussbaum, M., Gil, F., Villalta, M., Amestica, M., Echeverria, S.: A framework for the design and integration of collaborative classroom games. Computers & Education 57, 1127–1136 (2011)
6. Vogel, J.J., Vogel, D.S., Cannon-Bowers, C.A., Muse, K., Wright, M.: Computer gaming and interactive simulations for learning: a meta-analysis. J. Educ. Comput. Res. 34, 229–243 (2006)
7. Bakely, G., Skitrton, H., Cooper, S., Allum, P., Nelmes, P.: Educational gaming in the health sciences: systematic review. Journal of Advanced Nursing 65, 259–269 (2009)
8. Kebritchi, M., Hirumi, A., Bai, H.: The effects of modern mathematics computer games on mathematics achievement and class motivation. Computers & Education 55, 427–443 (2010)

A Review on the Concepts and Instructional Methods of Mini Digital Physics Games of PHYSICSGAMES.NET

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Abstract. Nowadays, besides MMORPG, many mini games designed for entertainment got popular on the Internet (e.g. Angry bird etc). The software scale of these games was smaller and these games could be played by mobile devices. Also, they had lower costs of development. The application of these games to education was potential and worth researching. This paper used content analysis method to gradually analyze 90 mini Physics Games on PHYSICSGAMES.NET. The authors discovered that the physical concepts these games covered were mostly mechanics presently; also, most games based on the two concepts, static equilibrium and throwing body movement. Regarding instructional strategies, almost half was problem-solving tasks plus instructional strategies of mastery learning. We further discussed the possible application and limitations of these mini games on instructional practices, and proposed relevant suggestions.

1 Introduction

The studies on the application of e-learning games to instruction and learning were becoming progressively more important. Digital educational games possessed the elements such as goal, rule, competition, challenge, fantasy, entertainment, etc. [1]. Also, digital educational games could combine the goals of the games with instructional objectives. Therefore, digital educational games combining with suitable instructional methods had pedagogical potential. Many studies have explored the potential of multiplayer online games for instruction [2],[3],[6]. Besides MMORPG, many single mini games designed for single-player were also very popular (e.g. Angry bird etc.). The software scale of these games was smaller and these games could be played by mobile devices. Also, they had lower costs of development. The application of these games to education was potential and worth researching. Within these games, many games were designed by using physical principles (e.g. mechanics concepts etc); thus, maybe these games were beneficial to learn physical concepts.

Technology-assisted instructions of physics concepts often applied simulation software. Digital games can offer fidelity of simulations [1] and problem solving tasks; besides, the challenging, entertaining, and interactive characteristics were helpful for

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students to promote their learning motivations. Therefore, learning physics concepts by using mini games will become one of the new future tendencies towards technology-aided physical instructional activities. Although there were fewer physics mini games designed specifically for instructional objectives recently, there were still many games provide players problem-solving tasks for inferring and thinking physics concepts. However, the evaluations of these kinds of games (e.g., physics concepts, instructional methods) were lacking. By reviewing and evaluating these mini physics games, this paper could provide as important references for designing future mini educational physics games.

The website, PHYSICSGAME.NET (http://www.physicsgames.net/), was one of the most internationally representative physics mini game websites. This website provided 90 free physics mini games for players. Each game was designed based on some kinds of physics concepts. To understand the instructional potential and limitations on the present physics mini games, this study aims to gradually analyze the concepts of the physics games (e.g. mechanics and electromagnetic etc.) and instructional strategies (e.g. mastery learning, situated instruction, and problem-solving tasks etc.) on the website.

2 Analytic Methods

This study adopted quantitative content analysis. We gradually played and analyzed the 90 mini games on PHYSICSGAME.NET. To analyze the categories of physics concepts in the games, the coders in this study categorized according to the general physical concepts, e.g. fluid mechanics, general mechanics concepts (other mechanics concepts except fluid mechanics), electromagnetic, and thermodynamics etc. Regarding instructional strategies, we categorized according to the common mastery learning, situated learning, and problem-solving tasks. Within these, if there were multiple concepts or multiple instructional strategies in the same game, we would give more codes for the game.

3 Results and Discussions

3.1 Analysis of Physical Concepts

After analyzing 90 Mini games, we discovered most games were designed by simply applying the general mechanics concepts. The mechanics plus fluid mechanics had 83 percentages which were higher than the other physics concepts. Because this category the general mechanics concepts covered a quite wide range, this study further analyzed deeply this category to find out which detailed mechanics concepts were frequently used in the game design. Within 80 games including the general mechanics concepts (excluding fluid mechanics), the categories of the use of detailed concepts were as Table 1.

From the results, we found that the games designed from the general mechanics concepts were mostly static equilibrium, and the next was throwing body movement. These two kinds covered 73 percentages of all categories of the general mechanics games. This phenomenon was worth our attention.

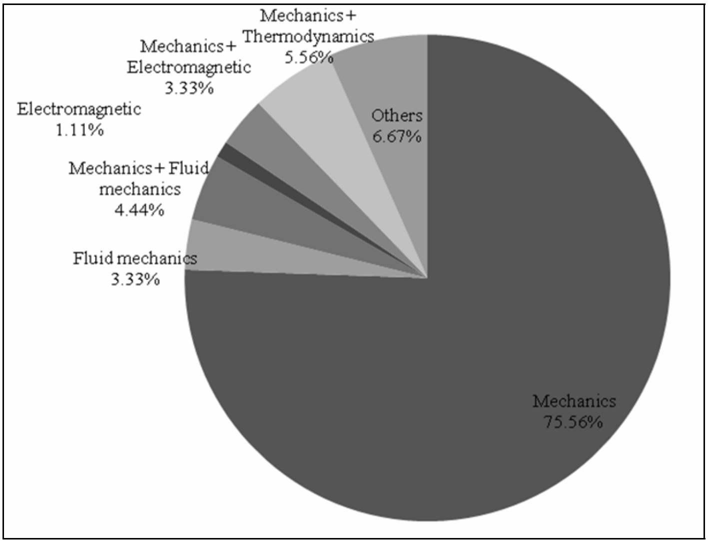

Fig. 1. Distribution of physics concepts applied by mini physics games on PHYSICSGAME.NET

Table 1. Distribution of the general mechanics concepts applied by mini physics games on PHYSICSGAME.NET

Categories	Numbers	Percentage
Static equilibrium	44	55%
Throwing body movement	14	18%
Slope movement	4	5%
Inertia	5	6%
Gravity	12	15%
Elasticity	1	1%

On the whole, most games on PHYSICSGAME.NET one-sidedly used the general mechanics concepts to design the games, especially static equilibrium and throwing-body movement. This demonstrated that these two concepts static equilibrium and throwing body movement comparing with other concepts were easier to be showed in the manner of games to a certain extent. However, we discovered that the physics concepts excluding mechanics, e.g. electromagnetic and thermodynamics etc. simply had few percentages within these mini physics games. This phenomenon also explained that if the mini physics games are used on instruction presently, the other subjects of the physics concepts except the general mechanics will still be restricted. We expected future researchers would design and develop relevant games.

3.2 Analysis of Instructional Strategies

Figure 2 showed above was the distribution proportion of instructional strategies of 90 mini games. The adoption of the instructional strategy of mastery learning plus problem-solving tasks had 51 percentages; this integrated instructional strategy was mostly extensively used, and the next was situated learning with a combination of mastery learning and problem-solving tasks (21%).

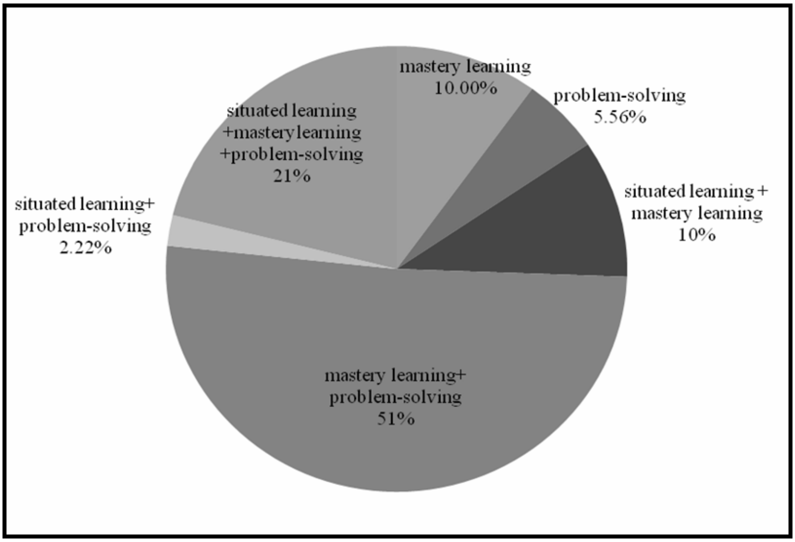

Fig. 2. Distribution of instructional strategies applied by mini physics games on PHYSICSGAME.NET

Analyzing through the important component elements the existing studies proposed [1], we found that all games on PHYSICSGAME.NET were small games; also, most of them were single games without sufficient social interaction. Therefore, to promote the players' motivations, these games focused on the use of the element "challenge". During the game, numerous problem-solving tasks with gradually increasing difficulty were mostly provided for players to accept physics problem-solving challenges. Through continuously repeated problem-solving, the users would get more and more familiar with the "goals" and operation of the games which helped the users reach the objectives of mastering physics concepts; also, for the sake of reaching the tasks of problem-solving games, the players continuously reflected to revise problem-solving strategies [4] to continuously maintain their motivations for the games and help change their concepts. Consequently, the combination of these two instructional strategies (i.e., mastery learning plus problem-solving tasks) could make the instruction combine with the games. Some plots of situated stories were put in parts of the games which made the games dramatic and made players have more motivations for learning because of role-play. However, the cost of design was higher. Although the number of the situated games was limited, it proximately reached one-third (about 33 percentages). From the past studies, we found that much software of game-based learning was drill-based games [5]. Nevertheless, this study discovered that within the mini physics games we analyzed so far, simply applying mastery learning strategy without combining problem-solving and role-playing situation strategy had only about 10 percentages. This phenomenon showed that these interactive physics mini games have developed towards the combination of diverse instructional strategies recently.

4 Conclusion

This study analyzed 90 mini physics games. The results demonstrated that the physics concepts these games included were mainly mechanics, and most games were based on the two concepts: static equilibrium and throwing body movement. Regarding the instructional strategies, about half of the games used instructional strategy of problem-solving tasks plus mastery learning. According to the results, we realized that these games were not designed especially for the educational needs; however, because the games covered some physics concepts and various integrative instructional strategies, using these games as assisted physics instruction to promote learning motivations (especially for the learning unit of mechanics) should be considered.

We also discovered some limitations of these games, e.g. the limitations on physics concepts these games covered. We suggested that future researchers and software developers can design mini games by using the other physical concepts excluding mechanics. Besides, we suggested that more role-playing instructional strategies and simulated realistic situations should be provided in the games. This design will help learners produce transfer of learning by immersing themselves in story scenarios and help them cultivate their ability to solve practical physics problems.

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References

1. Alessi, S.M., Trollip, S.R.: Multimedia for Learning: Method and Development, 3rd edn. Allyn & Bacon, Boston (2001)
2. Dickey, M.D.: Game design and learning: A conjectural analysis of how massively multiple online role-playing games (MMORPGs) foster intrinsic motivation. Educational Technology Research and Development 55, 253–273 (2007)
3. Dickey, M.D.: World of Warcraft and the impact of game culture and play in an undergraduate game design course. Computers & Education 56(1), 200–209 (2011)
4. Kiili, K.: Foundation for problem-based gaming. British Journal of Educational Technology 38(3), 394–404 (2007)
5. Ma, Y., Williams, D., Prejean, L., Richard, C.: A research agenda for developing and implementing educational computer games. British Journal of Educational Technology 38(3), 513–518 (2007)
6. Paraskeva, F., Mysirlaki, S., Papagianni, A.: Multiplayer online games as educational tools: Facing new challenges in learning. Computers and Education 54(2), 498–505 (2010)

A Flash-Based Game for Employee Doing On-the-Job Training

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Abstract. Educational games have been widely developed and tested by many researchers. Most of results show that the educational games are good to increase student's learning motivation in formal learning. It seems quite workable, however, what kinds of game-based learning a business really want to see and want to use? This research reveals the project of designing and implementing a game-based learning system within a real corporate environment. After been through the tough process of finding a company willing to adopt the game for its on-the-job training and orientation as well as the negotiations, the legal issues and the extensive scrutiny, it's amazing to find that what a real world company asks for is such a small and simple game. The game has been approved by the officer and ready to provide to phone and face-to-face sales who have no minimum necessary knowledge of selling watercrafts insurance and have interest in using game-based learning mode instead of PowerPoint presentation mode. The officer mentioned that he was quite happy with the game.

Keywords: game-learning learning, training, joy, computer game, educational games.

1 Introduction

Some researchers point out that playing can hold student attentions and make learning be more interesting [2][10]. For this reason, many studies use commercial games directly or design new education games and have evidences of students can get significant improvement in learning [1][6][8][10].

Several studies have been carried out on game-based learning with an educational orientation, especially for a possible use in either helping learning the traditional classroom environment, or supporting teaching activities [4], with improving techniques like the multi level challenge system [3]. Other game-based learning systems were, for examples, VISOLE [5], AnswerMatching [12], Shadow Box [7], and Simulation Fish Tank [9].

This paper describes a Flash-based On-the-Job Training game for teaching a mix of phone sales and face-to-face sales in R-Company boating regulation and insurance policy. This paper is organized into three sections, Section 2 talks the game itself and Section 3 reveals the evaluation plan.

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2 The Game

The process of recruiting a company willing to allow its employees to participate in an academic empiric research is not an easy task, when the subject of the study is Game-Learning. Armed with a mini-proposal and a sales plan explaining the benefits for an organization to help out with an academic study was not enough [11]. The word *game* represents a major road blocker, even after carefully explaining factual information regarding peer review studies showing game-learning systems as a powerful and effective learning tool.

The initial prototype was quite different from the final version of the game, basically due to the several changes initiated by the company. The involved employees take the project as something produced by their own department, and not an academic project. It was quite usual to receive a request to modify something related to the game, and not the training content itself [11].

This rest of this section describes the game and its mechanics, showing the details of how to play it and visually explaining all the steps of the tool.

The idea was to have a presentation style training embedded in a board game. In order to cut production and development time, the game was developed in Flash CS3, using ActionScript 2 in an Apple Macbook Pro 2.5 GHz with 4 GB memory. A prototype was initially designed and sent to the Learning and Development team of R-Company and evolved in the final game shown below. Without going into details, a brief description of the game mechanics is described below.

Figure 1 shows the screenshot of the game, with the presentation panel at the top left hand side with the pagination on the top right of the frame, the company logo at the top, the path for the sailing boat in dash style at the right hand side, plotted around the island, with pirate flags as part of the path. There is a start and finish lines, as in a boat race, at the bottom of the screen and the sailing boat parked at the start line. The finish line is a treasure "x". The green die with the button roll is at the bottom left hand side and right beside, on the right, is the points panel, with the 2 shark fins beside it. The shark fins are used to navigate through the presentation panel (back and forward).

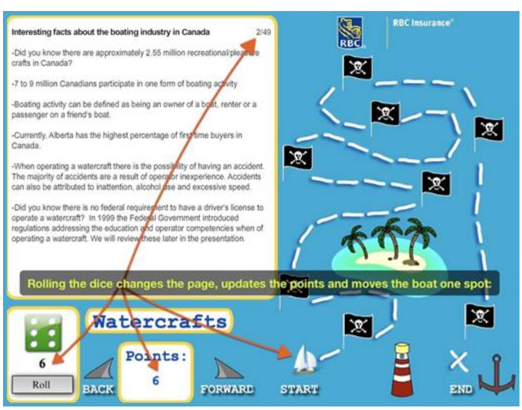


Fig. 1. Game Mechanics - how to move through the game

In order to start playing, the employee has to click in the button named roll, which will roll the dice, giving a number from 1 to 6. This number is going to update the points box, advance one chart in the presentation panel and no matter what number the employee rolled out, the sailing boat moves one spot (or dash) at a time. The points the employee receives at the end of the game currently is only for fun and s/he may compete with each others to see who has better lucky. There is "win" situation, but there is a scoring through points, so the objective of the game itself is to score as much points, as possible.

In order to bring up excitement, a challenging situation was created through the pirate flags: every time the boat moves to one of these 8 flags, the presentation panel will bring up a quiz, which has to be answered by clicking in the true, or false button: without selecting an answer, the game does not go on and the sailing boat will be stationary in the current position, with the roll button deactivated, as seen in Figure 2. The questions used in this quiz are exactly the same used for the pre-test, however, they were positioned after the corresponded charts teaching the respective subject. The use of the quiz was supposed to help with the engagement, at the same time as it would help in understanding the lessons and improving the learning process.

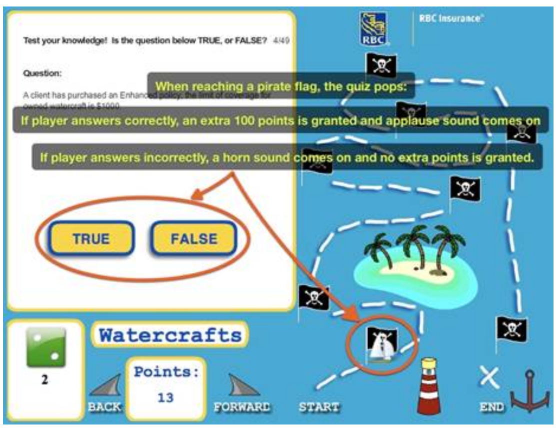


Fig. 2. The Quiz Process

The game will end when the boat reaches the "x", coinciding with the last presentation chart, which is number 49. At this moment, a voice saying "job well done" will play, the presentation chart in the presentation panel will inform the player about the end of the training and ask them to either play the game again, or to go to their post-test questions posted at the training portal.

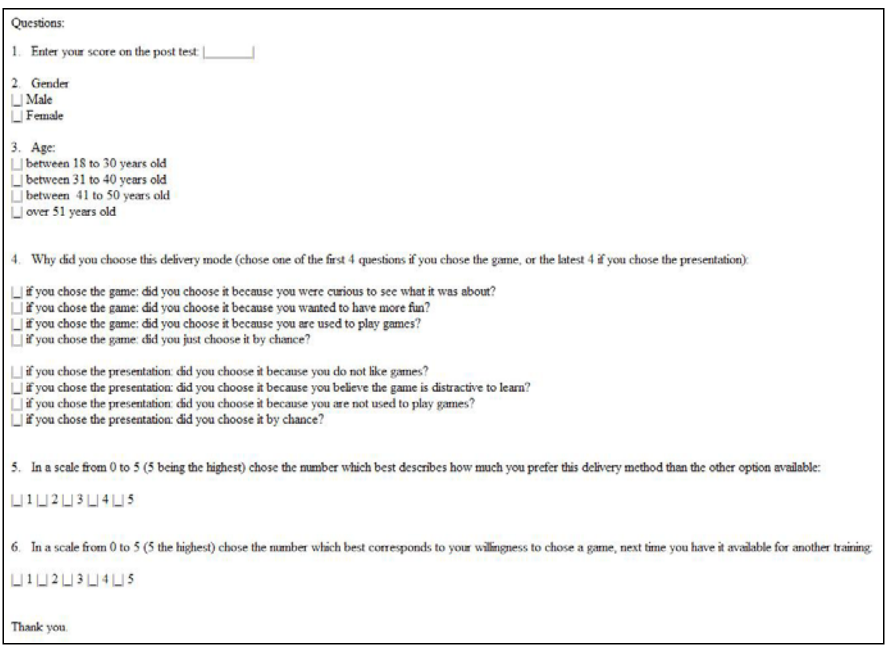
3 Evaluation Plan

The evaluation process starts with the pre-test of employees who need to have some skill set addressed in the training, and ends at the post-test to verify if the employee achieved minimum necessary knowledge after the training. If the employee doesn't achieve minimum required score for the pre-test, the employee needs to be exposed to the watercrafts training module, in order to sell watercrafts insurance.

The R-Company was delivering the training through electronic format, as a Microsoft PowerPoint presentation, however through Adobe Captivate, where it is possible to include voice. Once the employees finished the training, they have to sign in the training portal and complete the post-test, which is again, conditioned to the minimum score: if they fail, they have to re-do the training.

For this study, we plan to accommodate the game-learning tool as an option the employee should decide about: this measure would help in capturing the interest in the game format. The target of this evaluation plan is a mix of phone sales and face-to-face sales taking watercrafts knowledge and insurance selling training. Not all participants will use the game for training, the actual number of participants may vary depends on their pre-test performances and training mode preferences. Although we can not expect how many participants we will have due to they are screening by a pre-test first and the remains have option to take presentation-based training instead of game-based training, at least it is a real world project, which would show the results based on real life experience.

At the end of the process, a voluntary 6-item questionnaire as Figure 3 shows below is provided to the participants. The questionnaire is used to understand how the game was perceived by the people who chose the game, or the regular delivery format. Again, the reason of using this short questionnaire instead of 10- or 20-item questionnaire is fitting into the original on-the-job training process R-Company has, it turns out that we only have space for six items. Moreover, due to the information


Questions:

1. Enter your score on the post test:

2. Gender
- Male
- Female

3. Age:
- between 18 to 30 years old
- between 31 to 40 years old
- between 41 to 50 years old
- over 51 years old

4. Why did you choose this delivery mode (chose one of the first 4 questions if you chose the game, or the latest 4 if you chose the presentation):

- if you chose the game: did you choose it because you were curious to see what it was about?
- if you chose the game: did you choose it because you wanted to have more fun?
- if you chose the game: did you choose it because you are used to play games?
- if you chose the game: did you just choose it by chance?

- if you chose the presentation: did you choose it because you do not like games?
- if you chose the presentation: did you choose it because you believe the game is distractive to learn?
- if you chose the presentation: did you choose it because you are not used to play games?
- if you chose the presentation: did you choose it by chance?

5. In a scale from 0 to 5 (5 being the highest) chose the number which best describes how much you prefer this delivery method than the other option available:

1 2 3 4 5

6. In a scale from 0 to 5 (5 the highest) chose the number which best corresponds to your willingness to chose a game, next time you have it available for another training:

1 2 3 4 5

Thank you.

Fig. 3. The voluntary 6-item questionnaire

privacy protection rules, the questionnaire spends four items to gather participant's personal information includes post-test score, age, gender, and training mode s/he chose. We design the remained two items to ask the participant's perception towards the game-based training mode.

References

1. Anderson, T.A.F., Reynolds, B.L., Yeh, X.P., Huang, G.Z.: Video Games in the English as a Foreign Language Classroom. In: The Proceedings of the 2nd IEEE International Conference on Digital Games and Intelligent Toys Based Education (DIGITEL 2008), Banff, Canada, November 17-19, pp. 188–192 (2008)
2. Boyle, T.: Design for multimedia learning. Prentice Hall, London (1997)
3. Cheng, H.N.-H., Deng, Y.-C., Chang, S.-B., Chan, T.-W.: Design of Multi-level Challenges of a Digital Classroom Game. In: The Proceedings of the 1st IEEE International Workshop on Digital Game and Intelligent Toy Enhanced Learning (DIGITEL 2007), Jhongli, Taiwan, March 26-28, pp. 11–18 (2007)
4. Hsiao, H.-C.: A Brief Review of Digital Games and Learning. In: The Proceedings of the 1st IEEE International Workshop on Digital Game and Intelligent Toy Enhanced Learning (DIGITEL 2007), Jhongli, Taiwan, March 26-28, pp. 124–129 (2007)
5. Shang, J., Jong, M.S.-Y., Lee, F.-L., Lee, J.H.-M.: A Pilot Study on Virtual Interactive Student-Oriented Learning Environment. In: The Proceedings of the 1st IEEE International Workshop on Digital Game and Intelligent Toy Enhanced Learning (DIGITEL 2007), Jhongli, Taiwan, March 26-28, pp. 65–72 (2007)
6. Steinman, R.A., Blastos, M.T.: A trading-card game teaching about host defence. Medical Education 36(12), 1201–1208 (2002)
7. Sung, J.-Y., Levisohn, A., Song, J.-W., Tomassetti, B., Mazalek, A.: Shadow Box: an interactive learning toy for children. In: The Proceedings of the 1st IEEE International Workshop on Digital Game and Intelligent Toy Enhanced Learning (DIGITEL 2007), Jhongli, Taiwan, March 26-28, pp. 206–208 (2007)
8. Šisler, V., Brom, C.: Designing an Educational Game: Case Study of ’Europe 2045’. In: Pan, Z., Cheok, D.A.D., Müller, W., El Rhalibi, A. (eds.) Transactions on Edutainment I. LNCS, vol. 5080, pp. 1–16. Springer, Heidelberg (2008)
9. Tan, J., Biswas, G.: Simulation-Based Game Learning Environments: Building and Sustaining a Fish Tank. In: The Proceedings of the 1st IEEE International Workshop on Digital Game and Intelligent Toy Enhanced Learning (DIGITEL 2007), Jhongli, Taiwan, March 26-28, pp. 73–80 (2007)
10. Virvou, M., Katsionis, G., Manos, K.: Combining Software Games with Education: Evaluation of its Educational Effectiveness. Educational Technology & Society 8(2), 54–65 (2005)
11. Werneck, E., Chang, M.: Where Academics Meet the Real World: Difficulties Encountered when Conducting a Project for Designing a Game-Based Learning in a Company. In: Chang, M., Kuo, R., Kinshuk, Chen, G.-D., Hirose, M. (eds.) Learning by Playing. LNCS, vol. 5670, pp. 176–183. Springer, Heidelberg (2009)
12. Wu, W.M.-C., Cheng, H.N.-H., Chiang, M.-C., Deng, Y.-C., Chou, C.-Y., Tsai, C.-C., Chan, T.-W.: AnswerMatching: A Competitive Learning Game with Uneven Chance Tactic. In: The Proceedings of the 1st IEEE International Workshop on Digital Game and Intelligent Toy Enhanced Learning (DIGITEL 2007), Jhongli, Taiwan, March 26-28, pp. 89–98 (2007)

The Construction of Text-Based and Game-Based Teacher Career Aptitude Tests and Validity Comparisons

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Abstract. To improve the problem of teacher demand and supply imbalances and to facilitate student acquisition of information related to teaching and achieve talent selection optimization for education programs, this study creates a teaching situational judgment test for college students who desire to enroll in teacher education programs. Furthermore, this study develops a game-based teaching situational judgment test from the integration of game and simulation media to increase the accuracy of the situation, thus achieving the goal of increasing the validity of teaching situational judgment tests. This study performs validity analysis on game-based and text-based teaching situational judgment tests. The text-based teaching situational judgment test was evaluated to have high validity. The game-based teaching situational judgment test had the concurrent validity of the text-based test. Game-based teaching situational judgment tests were determined to be more suitable for current college students, based on validity and subject questionnaire analysis.

Keywords: teacher education, situational judgment test, games and simulation, game-based situational judgment test.

1 Research Objectives

Over the course of the last twenty years, the application of situational judgment tests (SJTs) to human resource selection has become an increasingly popular trend. Situational judgment tests can provide real working samples and have superior predictive power when compared to knowledge-based and personality-based tests, with regard to actual work performance [4]. Many studies indicate that excellent teachers should not only possess professional knowledge, but also professional work skills, including class management, educational administration, counseling and interpersonal communication abilities. However, currently existing teacher certification examinations are unable to reflect these professional work skills. Thus, we hope to use situational judgment tests to remedy the insufficiencies in current knowledge-based examinations. This study will engage in the construction of teaching situational judgment tests

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by using the Motowidlo, Dunnette, and Carter (1990) [7] construction method. In order to increase the accuracy of situational judgment tests, this study attempts to combine serious games to create a game-based teaching situational judgment test.

2 Research Method

2.1 Test Construction

The test construction process was performed by following the situational judgment test construction process outlined by Motowidlo, Dunnette, and Carter (1990)[7]. Various situations and responses are collected from subject specialists and edited into text-based situational judgment tests. Situational problem types can be divided into five main categories: Teaching/Evaluation, Class Management, Educational Guidance, Coworker Relations, and Parent-Teacher Communication, with a total of 34 problems. Based on the evaluation of expert organizations on each situational question, we organized the questions into multiple choice problems with four options each. Each question asks the subject to select two answers. The scoring for each question was between 4 and 0 points.

The game-based teaching situational judgment test was created by selecting eight questions from the text-based situational judgment test and paraphrasing the situation outlined in each question under the principle of not changing the original meaning. Thus, a few questions show cause and effect relationships in order to characterize student personalities and situation time contexts. The development tool used in creating the game-based situational judgment test was Virtools 4.0 developed by Dassault Systemes, software that can establish 3D environments and write programs. The test scoring standard was based upon the scoring previously provided by a teaching expert evaluation.

The post-testing questionnaires were self-made questionnaires for the primary purpose of understanding the feelings of test subjects towards the content and presentation of game-based and text-based teaching situational judgment tests, in addition to self-evaluation. The twenty-question questionnaire was measured using a seven-point system ranging from “Disagree Strongly” to “Agree Strongly.” The game-based and text-based teaching situational judgment tests and post-test questionnaires were presented through the medium of the Internet.

2.2 Subjects

This study used college students and in-service teachers as its research subjects. College students were divided into two groups; one group of freshmen, and one group of seniors currently taking teacher education courses. Adding the group of in-service teachers, there were three groups in all. The group of freshmen had 76 individuals who had not yet taken teacher education courses. The group of seniors had 50 individuals who had all taken teacher education courses. There were 68 in-service teachers. Several days after the subjects completed the test, 42 subjects were invited to take the test again. Every subject that was invited was a college student.

2.3 Survey Process

The entire testing procedure and notable points were explained before the conducting of the test. Then, each subject was asked to login to the system, which then proceeded to display the game-based situational judgment test, text-based situational judgment test, and post-test questionnaire for the subjects to complete. Only operational assistance was provided during the test. Subjects with questions related to situational content were asked explore the situation by themselves. There was no time limit, with each subject asked to complete the test at their own pace. College students spent one hour and twenty minutes on average to complete the test, while in-service teachers spent one hour and fifty minutes on average.

3 Research Results

3.1 Reliability

For reliability analysis, this study first applied the Cronbach α test to assess the internal consistency of the two situational judgment tests used in this study. There were a total of 8 game-based teaching situational judgment test questions. Analysis showed that the internal consistency coefficient was .35 ($N = 190$). There were a total of 29 text-based teaching situational judgment tests. Analysis showed that the internal consistency coefficient for these questions was .58 ($N = 194$).

In terms of reliability, the internal consistency of the situational judgment tests typically ranges from .43 to .94 [4]. However, situational judgment tests actually also measure work-related knowledge, skills, and abilities (KSAs) [11][4][6]. Using internal consistency as an indicator of reliability for single-concept tests is a good choice, but re-testing reliability may be a more acceptable indicator for reliability when tests involve multiple concepts such as situational judgement tests [8]. As such, this study also performed the collection of re-testing data to compensate for the inadequacies of internal consistency.

3.2 Validity

Test subjects were divided into three groups: freshmen, seniors, and in-service teachers. Single-factor analysis of variance was performed for the total scores of text-based teaching situational judgment testing. Results showed that the scores for text-based situational judgment testing showed significant differences for the factor of subject type, F (2, 191) = 13.63, $p < .01$. Analysis of test subject type provides evidence of discriminant validity, indicating that the text-based teaching situational tests produced by this study possessed validity.

Discriminant validity was also performed for game-based teaching situational judgment testing. The game-based teaching situational judgment testing produced by this study was unable to create segments between students and in-service teachers in terms of score. To examine whether game-based teaching situational judgment testing had concurrent validity with well-crafted text-based teaching situational judgment testing, we performed correlation testing for game-based situational judgment testing and text-based situational judgment testing. We first performed a correlation analysis for the total scores of game-based situational judgment testing with the total scores of text-based situational judgment testing. Results indicated that the correlation between the two types of total scores was .27 (N = 189), and that the correlation was significant ($p < .01$). These results show that the two types of tests had concurrent validity. However, game-based situational judgment testing was unable to discriminate between freshmen, seniors, and in-service teachers, producing results inconsistent with those of text-based situational judgment testing. As such, correlation analysis was performed for the total scores of the two tests for test subjects in different categories in order to determine whether more stable correlation results would be produced. Results indicated that the correlation for freshmen was .37 (N = 75), reaching significance ($p < .01$); and correlation for seniors was .30 (N = 50), reaching significance (p = .03). However, correlation for in-service teachers was .1 (N = 66), which did not reach significance (p = .44).

4 Discussion

In analyzing reliability, it was found that the game-based teaching situational judgment testing developed for this study produced weaker internal consistency, potentially for the following reasons. First, game-based situational judgment testing was performed using game and simulation methods, making the testing different from traditional testing methods. Performing testing using gaming and simulation methods provided test subjects with greater freedom to explore and to make choices during the testing process. So responses to the various questions were more diffuse than those for text-based situational judgment testing. Second, in the process of undergoing game-based situational judgment testing, test subjects may have been impacted by other factors, such as test subjects may not have been accustomed to testing performed using gaming or simulation methods.

In addition, it can be seen from the results for concurrent validity that game-based teaching situational judgment testing is particularly suited to students of this generation, consistent with the initial aims of this study in designing game-based situational judgment testing which combines gaming and simulation. However, in-service teachers, particularly experienced in-service teachers, may be less capable in computer usage than current students. It is apparent from post-testing surveys that in-service teachers found the system more difficult to operate than did current students.

Situational judgment tests are able to explain greater variance than other indicators of work performance, such as cognitive ability, personality, and professional knowledge and experience. That is to say, situational judgment tests have greater validity than these other indicators [1][2][10][11]. The new type of situational judgment testing developed in this study was developed based on a foundation of current information technologies and internet technologies. It can be foreseen that future testing will have greater accuracy and convenience. The multimedia teaching situational judgment testing developed in this study is a model for this new type of testing and can be expanded to other professional fields in the future.

References

1. Chan, D., Schmitt, N.: Situational judgment and job performance. Human Performance 15(3), 233–254 (2002)
2. Clevenger, J., Pereira, G.M., Wiechmann, D., Schmitt, N., Harvey, V.S.: Incremental validity of situational judgment tests. Journal of Applied Psychology 86(3), 410–417 (2001)
3. Lievens, F., Peeters, H., Schollaert, E.: Situational judgment tests: a review of recent research. Personnel Review 37(4), 426–441 (2008)
4. McDaniel, M.A., Morgeson, F.P., Finnegan, E.B., Campion, M.A., Braverman, E.P.: Predicting job performance using situational judgment tests: a clarification of the literature. Journal of Applied Psychology 86(4), 730–740 (2001a)
5. McDaniel, M.A., Nguyen, N.T.: Situational judgment tests: A review of practice and constructs assessed. International Journal of Selection and Assessment 9, 103–113 (2001b)
6. McDaniel, M.A., Whetzel, D.L.: Situational judgment test research: informing the debate on practical intelligence theory. Intelligence 33(5), 515–525 (2005)
7. Motowidlo, S.J., Dunnette, M.D., Carter, G.W.: An alternative selection procedure: The low-fidelity simulation. Journal of Applied Psychology 75, 640–647 (1990)
8. Ployhart, R.E., Porr, W., Ryan, A.M.: New development in SJTs: scoring, coaching and incremental validity. Paper Presented at the 19th Annual Convention of the Society for Industrial and Organizational Psychology, Chicago, IL (April 2004)
9. Prensky, M.: Digital natives. Learning in the Digital Age 63, 8–13 (2006)
10. Weekley, J.A., Jones, C.: Video-based situational judgment testing. Personnel Psychology 50(1), 25–49 (1997)
11. Weekley, J.A., Jones, C.: Further studies of situational tests. Personnel Psychology 52, 679–700 (1999)

Investigating Different Instructional Approaches Adopted in Educational Games

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Abstract. The present paper conducted a preliminary investigation attempting to examine how educational games implement instructional strategies to promote the players' deeper understanding. According to the criteria proposed in this study, five studies were selected from the Social Sciences Citation Index (SSCI) database for this review. Through the analysis, the instructional approaches reviewed consisted of prediction-observation-explanation (POE), self-explanation, collaboration, problem-based gaming (PBG), as well as guidance, reflection, and interactivity. In addition to description of each instructional strategy, limitations and possible remediation were discussed and proposed for future research.

Keywords: Game-based learning, science game.

1 Introduction

There is a growing trend on using educational games to promote and improve academic learning. Numerous studies point out that advantages of educational games consist of engaging students in learning activities, supporting learning by doing, and practicing problem-solving skills [1][7][8]. Even with these merits, it is still challenging for games designers to develop games that enhance deep learning. According to the researcher [4], many educational games tend to support the practice of factual information. That is, the players are inclined to keep performing certain of actions (e.g. clicking on a button) until the scores improve. Reflection becomes the last thing they do, which may impair generation of sophisticated understanding. Thus, researchers and educators encourage integration of instructional methods or pedagogy into the design of educational games. But, little attempt has been made. The purpose of this study was to review research studies of educational games so as to investigate how the instructional strategies were implemented in the games for enhancing the players' deeper understanding. This study also analyzed the limitations indicated in each study and proposed possible suggestions for future research.

2 Methodology

This is a preliminary investigation attempting to examine how educational games implement instructional strategies to promote the players' deeper understanding.

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The researchers searched the relevant papers by using the Social Sciences Citation Index (SSCI) database for this review. The selection criteria include: 1) implementation of educational game(s); 2) integrating instructional strategies or pedagogy; 3) offering measurement of students' learning outcomes. Five studies were found according to the criteria. The instructional strategies in each study were first introduced and then analyzed through the framework mainly including the targeted population, pedagogy, measurement of learning outcomes, and possible limitations.

3 Results and Discussion

The prediction-observation-explanation (POE)

A prediction-observation-explanation model is a potential approach to increase learners' conceptual change. According to the researchers [9], the model consists of three main tasks: predicting the outcome of an event or situation and justifying the prediction, observing the demonstration, and finally explaining the possible discrepancies or congruencies between their prediction and observation. In the study [1], the POE model was integrated into the game design to support the third-graders' acquisition of light and shadow concepts. In each stage of the game (four stages in the game), the players have to answer a question as well as justify the option selected before playing. During the observing process, the player has one minute to observe the shadow of the different objects (e.g. trees, chairs, or statues) through directing an avatar to walk around in the game context. This enables the player to understand what the accurate shadows of the objects look like. When the time is up, the player should identify five objects, randomly selected from ten, whose shadows were modified to be inaccurate forms according to the objective in each stage. When finishing each stage, a quiz pops out and then the player needs to answer a question as well as justify the option selected. The results show that those who played the game integrating the POE model outperformed those who did not in terms of the scores of the immediate test.

Self-explanation

Self-explanation is a method that prompts students to generate their own explanation orally, in writing, or through replying to a multiple-choice question. Its intention is to engage the learners in reflection during the learning process as well as to support the linkage between the newly learned materials and prior knowledge. The researchers [2] designed a circuit game incorporating a self-explanation feature. The goal of the game requires each player to solve ten circuit-related problems within a specific time. Scores are added or deducted whenever the players provide an accurate or inaccurate response to the problem. The players of a self-explanation group need to select a reason from a list before responding to the problem. The results show that those who played the self-explanation game outperformed those who played the game without self-explanation design. Regarding the type of self-explanation, those who selected a reason from multiple options gained higher scores than those who typed a reason themselves.

Collaboration

A number of studies have indicated that students can benefit from cooperating with peers in a learning activity [3]. Collaboration refers to a situation that two or more students work together on constructing knowledge and solving problems. In a game environment, collaboration enables players to guess and discuss about game moves, strategies, or arguments [7]. In the study [7] investigating the effects of cooperative learning on playing a computer game, the results show that the engagement of the students who worked in pairs did not decrease. Furthermore, they outperformed those who played individually in terms of the posttest scores.

Problem-based gaming

Problem-based learning (PBL) is an ideal way to engage learners in cognitive processes so that they can build knowledge or develop skills to solve problems effectively. The researcher [5] proposed a problem-based gaming model (PBG) that emphasizes the integration of authentic learning tasks, experiential learning, and collaboration into a game context. After the game-playing, players can easily transfer the learned knowledge or skills into practice since the targeted content had been anchored into the problem-solving situations of the game. In the study [7], the participants formed a team and played a business simulation game in which they needed to run a manufacturing company with a falling profitability. To compete with some groups, they should manage the material flows, read market reports, and come up strategies against their competitors. The results display that the students showed a positive attitude toward the PBG game. They felt themselves involved in learning by doing as well as generating reflective thinking during the game.

Guidance, reflection, and interactivity

A pedagogical agent (e.g. a talking head) refers to either static or animated anthropomorphic interfaces implemented in a multimedia context to serve different instructional purposes, such as offering feedback, prompting questions, or supporting interactions [8]. The researchers [6] conducted three experiments to investigate how students' deep learning was enhanced in an agent-based multimedia game that integrates instructional methods: guidance (the agent explains why an answer is accurate), reflection (learners are prompted to explain why an answer is accurate, and interactivity (learners are asked to respond to a problem instead of receiving an answer from the agent). The results show that either guidance or reflection was able to support students' science learning in a game context. In addition, reflection also fostered retention and far transfer only when the students were encouraged to reflect on the correct solutions provided by the agent (interactivity). That is, if asked to reflect on their own solutions, the students might not benefit from playing the game.

In summary, this study intended to increase the understanding of researchers and educators about integration of instructional methods into educational games. Its ultimate goal is to help them to decide what method(s) to be used to develop effective games that fulfill educational purposes. The analysis revealed that all the five studies identified a positive impact of educational games on improving the students' learning outcomes. Table 1 displays the summarized results of the five studies. As shown, most games conducted a knowledge test to assess the players' learning outcomes. A helpful suggestion, according to the researchers [7], is to offer the players another gameplay after the test so that researchers can examine whether the design can engage them in the game and to improve their learning gains. Educational researchers have identified social interaction as a potential to promote players' engagement and motivation, especially when implemented in a game environment supporting group discussion. Although two studies adopted a cooperation strategy in their game, those in groups merely used one computer. Thus, it is interesting as well as challenging for future studies to examine whether having each group member use one computer may impair learning outcomes. And, what strategies should be taken into consideration during developing the games? Of note, all the games in the five studies did not take adaption feature into the design, even though adaptive instructional systems have been proposed more than ten years.

Table 1. The summarized results of the studies reviewed

Author(s)	Pedagogy	Limitations or suggestions
Hsu et al. (in press)	Predict-observe-explain (POE)	• The design of narration might impose cognitive load on the preschoolers. • The participants' prior knowledge was not examined before playing the game.
Johnson & Mayer (2010)	Self-explanation	• The game context is too simple to match the complexity of computer games. • It is suggested to provide feedback or scaffolding to help the player generate self-explanation.
Kiili (2007)	Problem-based gaming	• Rigorous efforts on developing a game fulfilling the complexity. • Should support multiplayer connection. • Cognitive overload for those without sufficient domain knowledge.
Moreno & Mayer (2005)	Guidance, reflection, & interactivity	The study was limited to one type of interactivity, guidance, and reflection. Future studies can design various types of strategies and examine the effects on improving learning outcomes.
Van Der Meij et al. (in press)	Cooperation	• The game might be unable to support sufficient depth of the dialogues. • It is suggested to allow the players to another the gameplay after being tested to see if their learning outcomes are promoted. • Test feedback can be designed by having the players debrief about the essential game features.

The adaptive feature can accommodate individual differences, facilitate users' knowledge acquisition, and decrease the possibility of causing cognitive overload. To maintain a player's enjoyable and effective game-playing experience, it is encouraged to adapt the game complexity and scaffolding to approximately match each player's level of prior knowledge. Thus, the development of educational games that provide with alternative procedures and strategies for instruction will be a trend for future research.

References

1. Hsu, C.-Y., Tsai, C.-C., Liang, J.-C.: Facilitating preschoolers scientific knowledge construction via computer games regarding light and shadow: The effect of the prediction-observation-explanation (POE) strategy. J. of Science Education and Technology (in press)
2. Johnson, C.I., Mayer, R.E.: Applying the self-explanation principle to multimedia learning in a computer-based game-like environment. Computers in Human Behavior 26, 1246–1252 (2010)
3. Johnson, D.W., Johnson, R.T., Smith, K.: The state of cooperative learning in postsecondary and professional settings. Educational Psychology Review 19, 15–29 (2007)
4. Kiili, K.: Digital game-based learning: Towards an experiential gaming model. The Internet and Higher Education 8, 13–24 (2005)
5. Kiili, K.: Foundation for problem based gaming. British J. of Educational Technology 38, 394–404 (2007)
6. Moreno, R., Mayer, R.E.: Role of guidance, reflection, and interactivity in an agent-based multimedia game. J. of Educational Psychology 97, 117–128 (2005)
7. Van Der Meij, H., Albers, E., Leemkuil, H.: Learning from games: Does collaboration help? British J. of Educational Technology (in press)
8. Veletsianos, G.: Contextually relevant pedagogical agents: Visual appearance, stereotypes, and first impressions and their impact on learning. Computers & Education 55, 576–585 (2010)
9. White, R., Gunstone, R.: Probing understanding. Routledge, New York (1992)

Direct Lighting under Dynamic Local Area Light Sources*

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Abstract. Dynamic local area lights provide better realism compared with traditional artificial lights, which have been increasing in real-time graphic applications. This paper addresses the problem of real-time direct lighting under dynamic local area lighting by subdividing the original complex area lights into several virtual area lights (VALs) which have uniform radiosity. Then these VALs are used to illuminate the scenes in a closed form solution. Experimental results demonstrate that our method can be run in real-time without precomputation.

Keywords: Area Light, Summed Area Table, Direct Lighting, Real-time.

1 Introduction

Realistic image synthesis under dynamic local area light sources is a fundamental and inherently difficult problem in computer graphics. It requires evaluating of integral of lighting, visibility, and materials. The simulation costs of such computation prevent users from receiving real-time feedback on time-varying lighting condition and dynamic scenes.

Comparing with traditional point lights, area lights tend to reduce the variation of surface intensity and suffer less from the problem of highlight burnout in addition to added realism. Comparing with distance environment lighting, rendering under local area lighting is more difficult because we should consider not only the direction of the incident light but also the position. Current rendering methods usually focus on precomputation or point sampling, however they both have drawbacks. In this paper, we propose a novel direct lighting method with dynamic local area lighting which can run in real-time without precomputation, and support full-motion video on the light source and dynamic scenes. In this method, we mainly focus on rectangular area lights which have mid-range distance.

Our key contributions include the following:

- A novel representation of area light sources. The area light source is subdivided into several small virtual area lights (VALs) with uniform radiosity.
- A general summed area table construction method for each area light source during the running time, so that each VAL only needs four indexes to represent its world space position and radiosity distribution.

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- A specific application of VAL to direct illumination of diffuse scenes including time-varying area light sources such as a video screen.

2 Previous Work

Rendering with local area lighting has a long history in computer graphics. Recently, a number of general rendering methods have been proposed.

For the uniform diffuse polygonal area light sources, we can directly calculate the irradiance by an analytic formula [1-3]. Though Analytic methods give the most accurate rendering results and usually run fast, they can only handle simple lighting conditions, and only give direct lighting results.

More sophisticated area lights such as textured area lights or irregular area lights can be solved by point sampling base methods which convert area lights into plenty of point lights. There are a number of importance sampling methods such as structured importance sampling [4] which can make two orders of magnitude reduction of sampling point number, and bidirectional importance sampling [5] which generates samples from the product distribution of both the surface reflectance and illumination. Instance radiosity (IR) [6] traces light paths from the light source, and generates virtual point lights (VPLs) at the vertices of these paths. Cluster can also be used to improve the performance by getting multiple point lights together and represented by a single one, such as lightcuts method [7] and matrix row-column sampling method [8]. These techniques can approximate illumination from many point lights with a strongly sublinear cost. Although less sampling points are adopted to approximate the complex area lights, sampling for area light source methods are still hard to achieve real-time frame rates while maintain their image qualities.

Precomputed radiance transfer (PRT) [9] is an influential global illuminating technique that calculates the illumination of each point as a linear combination of incident radiance based on a precomputed approximation of the light transport function. Most of the PRT methods focus on distant lighting such as environment lighting. Kristensen et al. [10] extend previous work on PRT to local area lighting by introducing the concept of unstructured light cloud. Precomputed Light fields [11] can also support complex local area lighting that interactively render soft shadows for general dynamic scenes of rigid objects. However, precomputation based methods involve large storage costs and also impose strict limits on scene dynamism.

3 Our Approach

As explained in the introduction, we approximate the complex area light sources by several small VALs instead of many point lights. Each VAL has two positions and a light radiosity representing the average radiosity of the VAL.

3.1 Summed Area Table

We adopt summed area table to construct VALs and rapidly get their average light radiosity by just four indexes. A summed area table (SAT) is an array in which each entry holds the sum of the pixel values between the sample location and the bottom left corner of the corresponding input image, which enables the rapid calculation of the sum of the pixel values in an arbitrarily sized, axis-aligned rectangle [12].

Fig. 1(a) shows how to use a SAT to rapidly compute the sum of the pixel values of a selected rectangle region on the image. Four indexes are sufficient to get the integral result of the dark region, namely the bottom left corner (x_L, y_B) and top right corner (x_R, y_T) .

(a) (b) (c)

Fig. 1. Summed area table (a) and VALs (b). The whole area light can be divided into several VALs (b) and the illumination due to each VAL can be solved in closed form (c).

The sum of the pixel values of the dark region can be evaluated as $T(x_R, y_T) - T(x_R, y_B) - T(x_L, y_T) + T(x_L, y_B)$, where T is the value of the entry at (x, y) . Therefore, the average radiosity is the sum divided by the region size.

For each frame, we capture the current content of the dynamic local area light source and generate its SAT during the running time. To achieve better performance, we generate the SAT on the GPU by CUDA. We've implemented the recursive doubling approach described in [12] by CUDA. Two kernels are involved when constructing the SAT: the horizontal scan kernel and the vertical scan kernel. In each kernel, results are accumulated along scan lines.

3.2 VAL Rendering

Once we get the SAT for current area light, we can obtain the average pixel value B for any axis-aliened rectangular region on the light. We use a closed form solution to rapidly calculate the radiance due to each uniform VAL. This solution is based on the closed form solution for the form factor of differential area to rectangular [13]. For Lambert diffuse surfaces, the radiance at surface point y due to VAL a which has average radiosity B_a is:

$$L(y) = (\rho(y) \cdot B_a \cdot F_{y,a} \cdot \cos\omega_a \cdot \cos\omega_b) / \pi \tag{1}$$

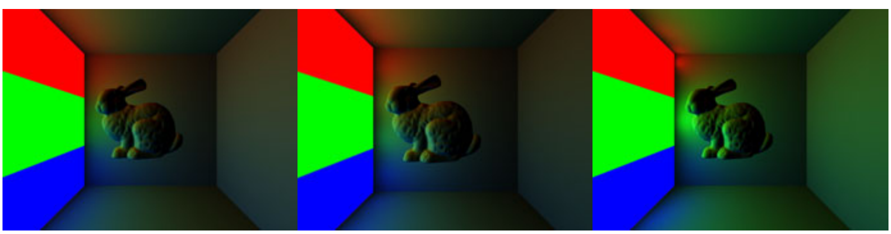
$$F_{y,a} = \frac{1}{2\pi}\left[\frac{x}{\sqrt{1+x^2}}\tan^{-1}\left(\frac{y}{\sqrt{1+x^2}}\right) + \frac{y}{\sqrt{1+y^2}}\tan^{-1}\left(\frac{x}{\sqrt{1+y^2}}\right)\right],\ x = \frac{u}{w},\ y = \frac{v}{w} \tag{2}$$

where ρ denotes the BRDF that controls the way the surface reflects light and distinguishes different materials. ω_a is the angle between the surface normal in y and the direction of incidence, while ω_b is the angle between the surface normal of area light and the direction of incidence. $F_{y,a}$ is point-rectangular form factor with the incident lighting direction perpendicular to the VAL. u and v denote the width and height of the VAL respectively, and w is the distance from shading point y to the VAL (Fig. 1(c)). The total radiance at y is accumulated by all of the VALs.

4 Experiment and Results

We have implemented above method using OpenGL and CUDA, running on a Intel Core 2 Quad with a GeForce GTS 250 graphics card supporting shader model 4.0. All images in this paper are generated using a final output resolution of 1024×768.

Fig. 2 compares the resulting images generated by point sampling based method and our VAL method. Fig. 2(a) uses 400 point samples that represent 400 VPLs. Fig. 2(b) uses 16 VALs (each tile showed in Fig. 1(b)) which gives almost the same image as Fig. 2(b) with much less rendering time. Fig. 2(c) reduces point sample number to 16. It is obvious that wrong rendering result is obtained. Bright splotches are observed on the wall because some VPLs are close to the point being shaded. Large quantities of VPLs can eliminate it.



(a) (b) (c)

Fig. 2. This figure compares the image qualities produced by point sampling based method with 400 VPLs (a) and 16 VPLs (c) respectively, and our VAL method (b)

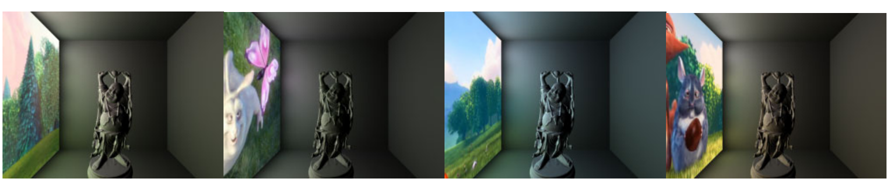


Fig. 3. Other images rendered by our method with full-motion video on the light source at real-time frame rates. All video stills are from “Big Buck Bunny”, (www.blender.org).

Fig. 3 illustrates several more images rendered by our method with full-motion video on the light source. The rendering time measurements of Fig. 2 and Fig. 3 are reported in table 1. The time for rendering one frame by VALs is nearly 10 times less than using 400 VPLs, and even less than 16 VPLs.

Table 1. Rendering time

Scenes	Triangles	VPL(16)	VPL(400)	VAL(16)
Fig. 2	69451	28.5ms	87.6ms	8.9ms
Fig. 3	1087716	43.0ms	162.0ms	21.5ms

5 Conclusion and Future Work

We presented a novel technique direct lighting scenes with dynamic local area light sourses at real-time frame rates. The original area light is subdivided into several VALs with uniform lighting radiosity. And then a closed form solution is used to render scenes due to each VAL. The whole technique requires no precomputation and is able to support time-varying area lights and dynamic scenes.

Our method currently ignores visibility. In future work, we plane to address this and also take indirect illumination into account.

References

1. Snyder, J.M.: Area light sources for real-time graphics. Technical report (1996)
2. Jams, A.: The irradiance Jacobian for partially occluded polyhedral sources. In: Proceedings of SIGGRAPH 1994, pp. 343-350 (1994)
3. Jams, A.: Applications of irradiance tensors to the simulation of non-Lambertian phenomena. In: Proceedings of SIGGRAPH 1995, pp. 335-342 (1995)
4. Agarwal, S., Ramamoorthi, R., Belongie, S., et al.: Structured importance sampling of environment maps. ACM Trans. on Graphics, 605–612 (2003)
5. Rui, W., Oskar, Å.: Bidirectional Importance Sampling for Unstructured Direct Illumination. Computer Graphics Forum, 269–278 (2009)
6. Laine, S., Saransaari, H.: Kontkanen. J., et al.: Incremental instant radiosity for real-time indirect illumination. In: Proceedings of Eurographics Symposium on Rendering (2007)
7. Walter, B., Fernandez, S., Arbree, A., et al.: Lightcuts: a scalable approach to illumination. ACM Trans. Graph. 24(3), 1098–1107 (2005)
8. Hašan, M., Pellacini, F., Bala, K.: Matrix row-column sampling for the many-light problem. ACM Trans. Graph. 26(3) (2007)
9. Sloan, P.–P., Kautz, J., Snyder, J.: Precomputed radiance transfer for real-time rendering in dynamic low-frequency lighting environments. ACM Trans. Graph. 21(3), 527–536 (2002)
10. Kristensen, A.W., Akenine-Möller, T., Jensen, H.W.: Precomputed local radiance transfer for real-time lighting design. ACM Trans. on Graphics 24(3), 1208–1215 (2005)
11. Zhou, K., Hu, Y., Lin, S., et al.: Precomputed shadow field for dynamic scenes. ACM Trans. on Graphics 24(3), 1196–1201 (2005)
12. Hensley, J., Scheuermann, T., Coombe, G., et al.: Fast summed-area table generation and its applications, vol. 24(3), pp. 547–555 (2005)
13. Cohen, M.F., Wallace, J.R.: Radiosity and realistic image Synthesis. Academic Press Professional, Inc., London (1993)

A Group-Based Load Balancing Approach for the Multi-service Distributed Virtual Environment*

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Abstract. In a multi-service distibuted virtual environment, objects can provide more services and become dynamic with greater effects in load balancing process, which is not considered in the previous work. Focused on the impact of dyanmic objects and their relationships with avatars to form workload-intensive groups when doing load balance, this paper proposes a group-based load balancing approach. Evaluation results show our approach can keep the system with dynamic objects stable regardless of the activities and increase of avatars in the system.

Keywords: multi-service distributed virtual environment, dynamic object, workload-intensive group, group-based load balancing approach.

1 Introduction

Distributed virtual environment (DVE) provides an internet-based platform for people from different places to communicate and interact with each other; moreover it provides services to them. Broll [1] illustrates that it is impossible for a single server to handle all required load and proposes the idea of partitioning the environment into regions managed by servers to reduce the load on a single server. Hence, in order to design a scalable and efficient DVE system, how to keep a load balance among servers becomes one of the key issues [2].

In a virtual environment, objects are used to provide services to users, while avatars represent users in the scene. Till now, most current DVE systems only provide objects with static information, considered as fixed workload. Thus, most load balancing studies are focused on effects of avatars [3][4][5]. Although some systems have considered objects such as [6], they are still considered as fixed workload.

However, with the development of DVE, objects are used to provide more interactive services, which are known as dynamic objects. And indeed, the movements and activities of avatars are random, so avatars with heavy load cannot reveal "hot" services on the server, while dynamic objects can reveal the status of services and bring

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in dynamic and changeable load onto servers. Besides, due to complex services between objects and avatars, they are more closely connected to each other.

With these in mind, considering the effects of dynamic objects and their relationships with avatars, we propose a group-based load balancing approach for such multi-service virtual environment.

2 The Workload-Intensive Group

Due to "hot" services of dynamic objects, avatars may gather in a small area and a "crowed" area will appear then. Therefore, not only the dynamic impact of objects should be considered, but also relationships between them and avatars should be involved. Our load balance approach is to distribute such "crowed" areas, denoted as *workload-intensive groups,* onto lightly loaded servers.

Since dynamic objects reveal the status of services, the workload-intensive group starts from dynamic objects with most workload. Then due to services between objects and avatars, hence, some avatars should be involved, which we denoted as *close* avatars of the object.

However, not all avatars of the object should be contained in the group because they have communications beyond the group. In deciding and choosing close avatars, we compare the communication costs of each avatar within the group denoted as C^{GL}, and beyond the group denoted as C^{OL}. Regarding the aims of less inter-server communication costs, we define the *correlation factor* *CF* to indicate the correlation between avatar a_i and the workload-intensive group G_j, expressed as $CF = C^{GL} - C^{OL}$, in which CF>0 means *close* avatar and should be included in the group. Then with *CF*, the process of finding close avatars of object O_j is as follows:

(a). Put all avatars that interacted with O_j into G_j.
(b). Calculate *CF* of each avatar in G_j.
(c). Sort the avatars based on *CF* and find out avatars that $CF \leqslant 0$. Eliminate these not-so-close avatars from G_j
(d). Re-calculate the *CF* of remaining avatars in G_j and repeat step (c) until there is no more avatars eliminate from G_j. Then get the initial workload-intensive group of O_i.

With the initial group in place, the next step is to extend this group by considering objects around to cover the crowed area. In this process, all neighbouring dynamic objects are placed into a candidate object set. Each time, select the one with the greatest load and find out its close avatars. If the total workload of the group including them is greater than balancing workload in demand, then they will not put into the group, but repeat this process of selecting objects from the candidate object set. Otherwise, put them into the group and place neighbouring dynamic objects of the dynamic object into the candidate object set and repeat this process, until the workload of this group comes to the value to ease the server, or comes to the situation that there is no object in the candidate set, which means the crowed area is covered.

3 Group-Based Load Balance Process

With the workload-group in hand, we come to discuss our group-based load balance approach. When saturation happens, the whole process can be divided into three stages: (1) get all information from other servers and find out local workload-intensive groups; (2) based on Round Trip Time (RTT) between servers, make a group-based load distribution decision; (3) appoint next server to start load balancing to run stage 2 and 3, until existing servers come to similar processing status. Next, we start a load balancing from current saturated server S_i:

Stage1. Get server local information and find out local workload-intensive groups;

step 1. S_i broadcasts Load Balancing Request (LBR).

step 2. When receive the LBR, other servers send Reply Load Balancing (RLB) with their local load, CPU utilization, and RTT with the S_i back to S_i.

step 3. When S_i gets all RLBs, it calculates average CPU utilization and its excessive load $C_{S_i}^{extra}$beyond average processing level. Then find out servers below average CPU utilization to form a Candidate Server (CS) list, denoted as $\{S_1 \ldots S_m\}$. The CS List is sorted according to the RTT with S_i.

step 4. With $C_{S_i}^{extra}$ as the distributing workload, according to sections 2, S_i finds out a list of workload-intensive groups to transfer, denoted as $\{G1, G2\ldots, Gn\}$, and sorted from large to small based on their communication costs beyond the group.

Stage2. Make group-based load balancing decision based on RTT;

step 5. With the CS List and group list, we start to make load balancing decision. Each time, select the server with the smallest RTT in the CS list as the target server. Then select groups to transfer to the server. Assume the target server is S_j and the group list denoted as $\{G^{Sj}\}$, then we want:

(a) $G^{Sj} \in \{G1, G2,\ldots Gn\}$

(b) $max_{\{G\}}\{\sum_{G^{Sj}} C^L(G^{Sj}, S_i)\}$,where $C^L(G^{Sj}, S_i)$ represents communication cost between group G^{Sj} and S_i.

(c) $\sum_{G^{Sj}} C^W(G^{Sj}) < C_{S_i}^{extra}$, means distribute workload should be within the acceptable workload of S_j.

step 6. Transfer $\{G^{Sj}\}$ to server S_j, modify $C_{S_i}^{extra} = C_{S_i}^{extra} - \sum_{G^{Sj}} C^W(G^{Sj})$ and remove S_j from CS List. If the group list is not empty, then repeat *step 5* until it reaches average.

Stage3. Appoint next server to start load balancing;

step 7. After S_i has distributed its excessive workload to other servers and receive DistributeEnd message from these servers, which indicates its load balancing done. Then it selects next server to distribute local workload according to their CPU utilization, which is above average processing level.

step 8. Assume server S_k is selected as the next load balancing server. Then S_i sends Load Balance Notification (LBN) message to S_k.

step 9. When S_k receives LBN, it runs the whole load balancing process to make a local balance and then forward this to next server as S_i did.

4 Experiments and Discussions

In our simulation, the virtual environment is 450×450 cells. There are N_O virtual objects and N_A avatars, with the proportion of dynamic objects $p\%$. The complete VE is partitioned into N_S regions and distributed by each server, where $N_S << 450 \times 450$. Both the server and the client programs run on PCs with a Pentium IV 3.00GHz CPU and 512 MB RAM. To monitor the performance of our approach, we measure two metrics: the CPU utilization of servers and response time of an avatar. The response time of an avatar measures the average time required to get all information of objects and avatars in the view scope. The CPU utilization shows the workload and processing status of a server. In the following part, we present two experiments to quantify the performance of our group-based load balancing approach.

In the first experiment, the effects of dynamic objects in the system performance are studied. N_A is fixed at 120 and with 1 server. The number of objects, N_O, ranges from 1K, 2K, 4K and 6K, and the proportion of dynamic objects is 0%, 15%, 30% and 60%. The measurements of the two metrics are shown in Fig 1. Fig 1(a) and 1(b) shows the metrics versus the number of objects while Fig 1(c) and 1(d) give out the metrics versus the proportion of dynamic objects in the environment.

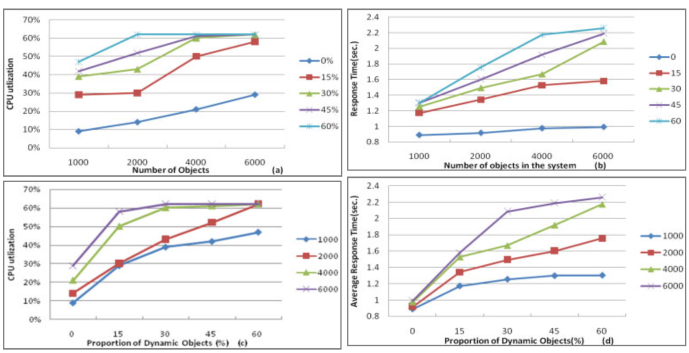

Fig. 1. The effects of dynamic objects

When comparing Fig 1(a) and 1(c), 1(b) and 1(d) we can see the proportion of dynamic objects have bigger effect on the CPU utilization and response time. This is because the processing of interacting with avatars bring more workload and network traffic into the system. But the effects of the number of objects and dynamic proportions on CPU utilization are greater at first, when the number of dynamic objects reaches around 1200, the value of CPU is around 60%. That is because although the number of objects and its proportion of dynamic objects increases, the needs of avatars are limited, due to the fixed number of avatars in the system, which is 120 currently. And the growth of response time also slows down due to the same reason.In the second experiment, we study our group-based load balancing approach. The number of objects is fixed at 6000 with a proportion of dynamic objects as 60%. The number of servers is 4 and the initial number of avatars is 60. The customised maximum CPU utilization is set to 40%. With 60 avatars accessing into the system every time, we add 240 avatars into the current system. We depict CPU utilization on each server. The measurement of this experiment is shown in Fig 2.

In Fig 2(a), we can see when new avatars access into the system, the CPU utilization of server 1 will increase over 40%, which because we put more dynamic objects on it to show crowd area, but finally, after the load balancing process, the CPU utilization on each server is kept below the saturated value and around the same level, which means, the approach can provide a good balance when new users access. When consider the network condition response time in Fig 2(b), we can notice that it steadily increase with avatars accessing into the system and keep good performance for network traffic between users and servers.

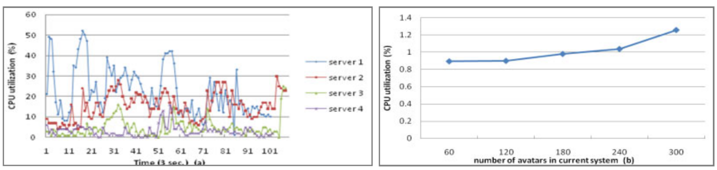

Fig. 2. The evaluation of the group-based load balancing approach

5 Conclusion

With the development of virtual environment, more interactive services are provided by dynamic objects, which can reveal the status of services and affect system performance greatly. In consideration of the effects of dynamic objects and their relationships with avatars, we propose a group-based load balancing approach. Finally, experiments show that dynamic objects affect the system performance dynamically and greatly, while with the increases of users, our approach is effective in maintaining a similar processing level among servers and providing good network performance.

References

1. Broll, W.: Distributed Virtual Reality for Everyone-a Framework for Networked VR on the Internet. In: IEEE Virtual Reality Annual International Symposium 1997, pp. 121–128. IEEE Computer Society Press, Los Alamitos (1997)
2. Lui, J.C.S., Chen, M.F., So, O.K.Y., Tam, T.S.: Dynamic Partitioning for a Distributed Virtual Environment. Department of Computer Science, Chinese University of Hong Kong (1998)
3. Deng, Y.H., Lau, R.W.H.: Heat Diffusion Based Dynamic Load Balancing for Distributed Virtual Environments. In: Proceeding of the VRST 2010 (2010)

4. Morillo, P., Orduna, J.M., Fern´andez, M., Duato, J.: Improving the performance of distributed virtual environment systems. IEEE Transactions on Parallel and Distributed Systems 16(17), 637–649 (2005)
5. Wei, N., Cai, H.M., Jiang, L.H.: A dynamical adjustment partitioning algorithm for distributed environment systems. In: Proceedings of the 7th ACM SIGGRAPH International Conference on Virtual Reality Continuum and Its Applications in Industry, vol. (9), ACM, New York (2008)
6. Bouras, C.D., Giannaka, E., Panagopoulos, A., Tsiatsos, T.: Distribution and Partitioning Techniques for NVEs: the case of EVE. In: IEEE Challenges of Large Applications in Distributed Environments, pp. 73–82 (2006)

Research of Emotion Promoting Teaching Interaction in Virtual Learning Community — A Case Study of Virtual Learning Community Based on Blackboard

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Abstract. Virtual learning community is one of the most important issues in online education. In order to inquire how emotion promoting teaching interaction, this paper analyzes the phenomenon in one community based on Blackboard. Making use of descriptive statistics and characterization statistics that describe the teaching interaction, we reveal the situation of its emotion interaction and teaching interaction. Conclusions are drawn on the basic of the situation that emotion can increase students' motivation for learning, promote teaching interaction as well as help to develop students' higher capabilities.

Keywords: Virtual Learning Community, Emotional Interaction, Teaching Interaction.

Virtual learning community is a hot of the current remote education research, it's rapid development, provides a good opportunity for online learning research and remote education. Virtual learning community provide an interactive learning experience environment for online learners, learners can according to their interested topic participate the discussion of community, and exchange learning experience with learners who has the same interests. Virtual learning community has a virtual community of some of the elements, but also should be Tonnies called "social relationship" or "spiritual community" level of the existing virtual community. Thus, in the form with administrative autonomy and volatility of the virtual learning community, the emotional factor is particularly important; affect the interactive process of teaching and teaching effectiveness.

1 Emotion and Emotional Interaction

Emotional and interactive relationship is the network education research in one of the important research areas. I use CNKI retrieve the source for the past five years CSSCI

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emotions and feelings about the journal article analysis of interaction, the article main research can be divided into: teaching design theory of emotional areas, the influence factors of the emotional interaction analysis, emotional loss causes and strategies, emotional interaction model design and teaching design, teachers using emotional factors of research, etc. But to the promoting function of emotional interaction, namely affection for learners of interaction between the roles is very little.

Theoretical proof, effective communication = 55% appearance and body language + 38% + 7% language content tone intonation. Believe that the three elements of communication are subject to emotion and emotional impact of the effective interaction. In the traditional classroom, the three elements of communication which can be reflected in the teaching interaction, emotional communication is observable. But in network learning, teachers and students separated in space need the help of the teaching environment and teaching media and the establishment of its teaching on the interactive communication. Therefore, in virtual learning community and other network learning environment, emotional and emotional interaction has the following characteristics:

- Regional emotional interaction across time and space
- Genuineness and equality of emotional interaction
- Easy mobility of emotional interaction
- The instauration of emotional interaction

2 Teaching Interaction of Virtual Learning Community

In foreign countries about the virtual learning community research dated from 1991, and studying interactive phenomenon are also earlier. Even so, every domestic and international experts and scholars about connotation understanding of “interaction" are not same. The following is the representative definition and explanation of interactive teaching:

Table 1. Teaching interaction definition contrast [1][2][3][4]

Researcher	Interactive subject	Interactive object	Interactive type
Moore	(1) Learner (2) Teacher	Learning content	(1) Learners and learning content interaction (2) Learners and teachers interaction (3) Learners and learners interaction
Laura Reiter	(1) Learner (2) Teacher	(1) Learning content (2) Environment of learning activities	(1)Adaptability interaction: the interaction between learners structuring the environment, in campus auxiliary virtual learning community, teachers will according to a theme create learning environment, learners will according to the mission continuously adjust their behavior to finish work. (2)Conversation interactive: learners' adjusting their own behavior will affect concepts restructuring in the mind and expansion of their own cognitive structures; the teachers' explaining about concepts will make learners change about the understanding of the knowledge.

Table 1. (*Continued*)

Chen Li	Learner	(1) Learning content (2) Environment of learning activities	(1) Operation interaction between students and media interface (2) Information interaction between students and teaching elements ✧ Students and learning resources interaction ✧ Students and teachers interaction ✧ Students and students interaction (3) Concept interaction between students' concepts and the new concept

According to the above tells, we make a definition about the meaning of interaction in virtual learning community: the interaction in virtual learning community is a kind interaction between learners in the process of achieving learning goals or gradually closing to learning goals and all kinds of learning resources of community, this interaction not only includes learners and teachers, media interface and study contents of interaction, also includes the communication between the learners, learners have known concepts and new concepts of the interaction.

3 The Study of the Case about Instructional Interactive Affected by Emotions

3.1 Case Selection

The case was one course selected from courses of the second semester in 2008-2009 in Peking University. And it was named virtual learning community based on the blackboard curriculum management system. The blackboard system would give a good support for teachers and students from whether the Curriculum organization or communication between teachers and students. The teacher had a centralism teaching every week with the way of traditional face-to-face teaching combined by virtual learning community. The course was held with virtual learning community assisted by the traditional campus for the first time, so teachers students would like to attempt a new instructional method. Then the data recorded in the community could reflect the interactive fact objectively both between teachers and learners and between learners and learners.

The sample was composed by 13 people. There were two teachers in charge of the course. One of them organized topic 1 and 3 and the other topic 2. There were 11 people taking the elective course. 6 of them selected the course formally and need to get credit. The other 5 were auditors and they needn't credit. We applied S1-S11 to the code for students and T1-T2 to the code for teachers.

3.2 The Analysis Framework

Every interaction in Virtual learning community was about the specific contents decided by teachers or students. The author considered that a standard coding system should meet the following conditions: Coding system must cover every news of virtual learning community; Standard coding system category should apply to the news flow of similar theme in the different community; the classification system of Coding system should be moderate and could not be too broad or too careful. In this paper, the encoding of virtual learning community is divided into two kinds. One kind is descriptive statistics and the posting situation of participants in virtual learning community; the other kind is characteristic statistics and it is to react teaching interaction related to emotional interactive in this community.

In regard to the posting situation the coding system of this research was as follows:

Table 2. The analysis coding of the posting situation

designation	code	description
number	1	The serial number of participant in virtual learning community
The number of initial posts	2	The number of initial posts from every participant in virtual learning community
The number of single posts	3	The number of initial posts that hadn't any replies
The number of following posts	4	The number of all the replying posts aiming at every initial posts
The number of all the posts	5	The number of all the initial posts and replying posts towards every participant
The number of words	6	The number of words in all the posts towards every participant
the reading times	7	the reading times of the posts towards every participant
The average times	8	The average times of the posts towards every participant

About the contents dimensions of the interaction classification system, domestic and overseas scholars had done related elaboration[5][6][7][8]. Some experts' classification of the message contents was too wide. That is to say, these experts could not be very careful to classify the message contents. In addition, because of different scholars choosing different types and crowd of virtual learning communities the selections of coding systems were different. Main purpose of this article was to explore the promoting functions of emotions towards interaction, namely the functions of the emotional communication towards interactions among learners. According to the definitions and characteristics of the emotions and emotional interaction and with the interactional key ingredient variables into consideration the coding classification of cases was as follows:

3.3 Reliability and Validity

In order to improve the level of reliability in this study, both descriptive statistics and characteristic statistics, we select the two researchers are encoded in a common

Table 3. Teaching interaction classification Based on Emotional factors

Behavior classification	code	Operational definition	Behavior sign
support	1	The behaviors that we made timely feedback for the behavior and ideas of teachers or other students and published their own opinions	● Support others' opinions ● Agree with others and add something
conflict	2	The behaviors that we have different opinions towards teachers' opinions and behaviors or other students' opinions and behaviors and opposed their opinions	● Present opposite ideas or opinions ● Not agree with others ● Replace the opinions we learned with others' opinions
query	3	The behaviors that we had doubt about other learners' opinions, but don't give negative	Put forward our doubts about others

classification to ensure the accuracy of the results. In order to improve the validity of the study, the author access to research data from two ways, on the one hand from the virtual learning community platform for research data; the other hand, the learners participate in the program learn to conduct interviews to collect data. In addition, I will apply the same coding system has a similar background in the different themes of community, the multi-group data were analyzed.

3.4 Case Study

A From Descriptive Statistics to See Effect of Emotion on Teaching Interactive

Virtual Learning Community and Web-based course has a lot in common, so author by research article about network courses in the effect emotion interactive of factors and the promote strategy in recent years to found that emotional exchange reflected and restricted in the following areas (a) Students: natural situation, learning situation and style, motivation and state (b) Teachers: teaching thought, organization method and teaching policy (c) Courses construction: courses guidance, resources quality, teaching design and operation interface (d) Culture atmosphere and the construction mechanism (e) hardware and software environment. This article is a case study, so influenced by the case. I extract the learning motivation of students and teachers ' strategies to using descriptive statistics as mentioned above explore the effects of emotions on teaching interaction.

1) Learning motivation of students

The virtual learning community students are divided into two types of elective students and auditors. Elective students were officially choosing course students. They have a clear learning objective at the beginning of the term. Completion of courses based on the cultivation credits. Auditor is not an elective course student; they do not have credit and work pressure in the course. These two types of student performance with a very big difference in terms of motivation. I used descriptive statistics for both types of students a comparative analysis of post as mentioned before. Elective students there is a difference in first posted, the number of threads and total posted under different topics. Auditor’s first posted the number of threads and total stick under the difference is not significant in different themes. There is no significant difference between elective students and auditor in independence posted number. In addition to "no response poster" and "average response number", the elective students indicators are far higher than the auditor. Calculate significant difference on the two types of students in the overall statistics.

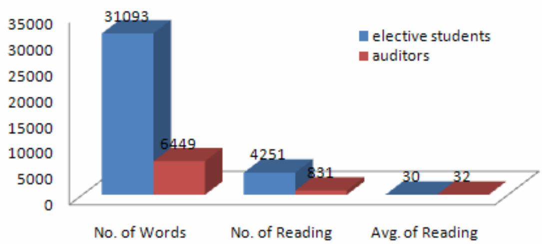
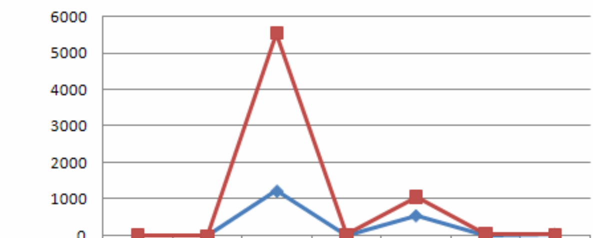


Fig. 1. Reading Numbers from students of different Learning motivation

2) Teaching strategies of teacher

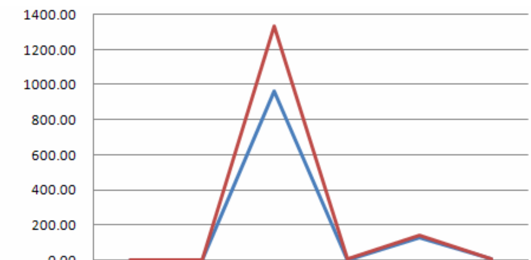
The virtual learning community is divided into three themes. T1 is responsible for the first and the third topic of teaching and discussion, T2 is responsible for the second theme. In order to explain teaching strategies on teaching effect of interaction better, author make comparative analysis on two topics taught by T1. T1 changes teaching strategies topics III compared with the first theme, made more open-ended questions first post. Published problem more clearly and topic is more suitable for in-depth discussion and assistance exchange. In the interactive process by " appropriate provide guidance, advice, suggestion or feedback" and other ways to encourage and guide the students exchange.

Although the decrease in average first posted of topic three students in this strategy, the total volume in the community and students of average post word count, number of threads posts, average number of read posts had significantly improved compared with the theme one. This reflects the "teacher-led, student-centered" teaching model better and observation to the students on the topic under discussion were more thorough in this teaching strategy.



	First Poster	No Response Poster	No. of Words	Response posters	No. of Reading	Total of Posters	Avg. No. of Reading
Topic 1	2	0	1233	9	558	11	51
Topic 3	7	0	5552	39	1061	46	23

Fig. 2. Posters from teachers of different Teaching strategies



	Avg. of First Poster	Avg. of Poster without response	Avg. of Words	Avg. of Response	Avg. of Reading	Avg. of Posters
Topic 1	0.91	0.18	966.64	2.73	129.45	3.64
Topic 3	0.64	0.00	1332.73	6.64	138.09	7.27

Fig. 3. Posters from students of different Teaching strategies

B From Characteristic Statistics to See Effect of Emotion on Teaching Interactive

Table 4. Teachers and students code analytical result form

participants \ Coding	1	2	3
T1	16	1	1
S1	5	4	0
S2	5	4	2
S3	1	0	1
S4	7	0	5
S5	8	2	0
S6	5	1	2
S7	0	0	0
S8	2	1	0
S9	0	0	0
S10	4	1	1
S11	0	0	0
T2	2	1	0
Total	55 (67%)	15 (18%)	12 (15%)

Table4 The coding results in table

theme \ coding	1	2	3
theme 1	22	0	2
theme2	8	9	1
theme3	25	6	9
total	55	15	12

We have categorized interaction about the interaction of emotion in virtual learning community in the earlier. After statistical analysis of all the posts, I came to a as shown in table 4 acts of interaction results. We can see that T1 on the interaction of statistics number is very high and T1 is the body of the whole interactive process. Students ' behavior of the S7 to S11 have lower statistics that shown the group at edge in the entire interaction process. I analysis of emotional interaction from a different theme. Statistics also show less feelings interaction of T2, thus affecting teaching interaction. T1 is responsible for the theme of emotional interactions is relatively high; among students between teachers have more interactive behavior. T1 changed teaching strategies in the theme three that resulting "questioned, conflict and support" behavior are higher than first theme. The data consistent with the analysis of earlier conclusions.

Query, conflict and support corresponding to the positive, negative or neutral of "emotion". Although the percentage of "query" and "conflict" relative "support" is less. After analysis the post which shows two kinds of emotions, the author found that both kinds of posts have following post, and the depth of post which aims at "conflict" is more thoroughly than other posts. On average the number of every post was reading times is greater than another post.

4 Conclusion

In the virtual learning community, the emotional interaction is affected by students, teachers, courses and mechanism. The good emotional interaction can promote the student's study interest, stimulate students deeply discussion, increase the number and frequency of interaction between teachers and students. Concretely come to speak, emotion to influence with teaching interaction is mainly shown as under aspects:

- To enhance students interactive power.
- Promote the interaction between students.
- To cultivate students' ability of high order.

Reference

1. Moore, M.G.: Editorial: Three types of interaction. American Journal of Distance Education 3, 1–6 (1989)
2. Li, C.: A Hierarchical Model for Student and Teacher Interaction in Distance Learning. China Distance Education 3, 24–28 (2004)
3. Hillman, D.C.A.: Learner-Interface Interaction in Distance Education: An Extension of Contemporary Models and Strategies for Practitioners. American Journal of Distance Education 8, 30–42 (1994)
4. Ding, G.D.: Ding. Research and Design of Operational Interaction in Web-based Courses. D. Jilin University, Jilin (2006)
5. Newman, D.R., Brian, W., Clive, C.: A content analysis method to measure critical thinking in face-to-face and computer supported group learning. Interpersonal Computing and Technology 3(2), 56–77 (1995)

6. Zhu, E.: Meaning negotiation, knowledge construction, and mentoring in a distance learning course. In: Proceedings of Selected Research and Development Presentations at the 1996 National Convention of the Association for Educational Communications and Technology, Indiana polis, pp. 821–844 (1996)
7. Gay, G., Pena-shaff, J., Martin, W.: An Epistemological Framework for Analyzing Student Interactions in Computer-Mediated Communication Environments. Journal of Interactive Learning Research 1, 41–68 (2001)
8. Alan, T., Long, C.: Student Support in Open and Distance Learning. China Distance Education 15, 15–23 (2003)

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