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Trends, Profiles and Modeling Perspectives

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Epitome

The term Blended—viewed as a fuzzy concept—can be understood as a stepping-stone on the way to the future, to explain the multiple ways human beings think/act/feel of society in the twenty-first century and to embrace the opportunity of humans to re/co-construct new knowledge through the intermediation role of the technology. Blended(b-) Learning, during the last few years, has been well-accepted by many institutions, becoming increasingly the modality of e-learning, however, thinking forward, it is particularly capable to incorporate the process of transitioning toward an Intelligent Learning Management System. This book aims at investigating the conceptual, cultural, educational, and innovative landscape, in the context of intelligent online learning environments (iOLEs), underlining the thinking and behavior/action of Learning Management System (LMS) users. Initially, based on a theoretical framework for the development of OLEs, some current issues of the process of teaching and learning in the digital age are characterized, analyzed, and reflected on potentialities and constraints that Web 2.0 communication tools can offer in an educational context. Furthermore, and after explaining/justifying the main technical and methodological procedures, characteristic examples of research studies developed toward such endeavor follow. Overall, supported by b-learning contextual analysis, the profiles and needs of users (teachers/students) of five courses (Sport Sciences, Ergonomics, Dance, Sport Management, and Psychomotor Rehabilitation) offered by a public Higher Education Institution (HEI), i.e., Faculty of Human Kinetics (FHK), University of Lisbon (Portugal) are identified. Finally, the FuzzyQoI model, based on the fundamentals of Fuzzy Logic inference systems, that estimates the Quality of Interaction (QoI) of the LMS Moodle users is presented and discussed, revealing a clear opportunity to be used with any LMS Moodle. In an effort to better understand this complex multifaceted b-learning environment, the structural unit of this book contributes expressively to improve instructional practice, insofar as diagnoses-specific contextual needs and also suggests future models, perhaps more suited and more intelligent to blended communities of practice. At the same time, this book offers useful information that evokes initiatives toward rethinking of the value, efficiency, inclusiveness, affectiveness, and intelligence of the LMS-based b-learning environment, both by the educators, the LMS designers, and educational policy decision makers.

Overture

Teaching is the highest form of understanding
—Aristotle (384–322 BC)

Recent scientific and technological developments around the Technologies and Education reactivate the discussion on the theme of teaching-learning process as a complex and constantly dynamic reality (Bates 2005; Garrison and Kanuka 2004; Peters 2001). In fact, the use of Information and Communication Technologies (ICTs) in teaching and learning is an indicator of strong motivation for innovation within the educational context (Ala-Mutka et al. 2008; Coutinho and Bottentuit Junior 2007). In turn, new hybrid modes of expression, supported by collaborative techniques in interactive environments of the *pronétariat*[1] (Rosnay 2006, p. 12), seem to create new opportunities/challenges. In other words (Visser 2005):

> There are new opportunities for the mentor working in the Web-based environment and to play an active role in the significant development of social negotiation and collaborative learning skills (p. 296).

From an understanding of this perspective, interactive environments perceived as determinant factor in online learning directly influence success of the outcomes of learning, knowledge construction, and the quality of online learning *per se* (Maor and Volet 2007). Indeed, during the educational processes, the increasing amount of the interaction allows a more flexible learning, diversified and individualized, anytime and anywhere (Bates and Sangrà 2011; Ifenthaler and Pirnay-Dummer 2011). Correspondingly, the integration of multimodal, multisensory, and non-linear interactive systems seem to offer pronounced potential to enlarge learning opportunities and reinforce the assumptions behind the construction of the individual knowledge (McGuire 1996). In addition, there has been a rapid and noticeable trend to integrate various systems of information and communication in the process of technological innovation from universities and/or organizations (e.g., videoconferencing, virtual campus, synchronous/asynchronous collaboration tools, instructional modalities in electronic (e-)/blended (b-)/mobile (m-)learning) that certainly reflect distinct sociocultural, economic, and technological identities

[1] The *pronétariat* concept can be understood as a new social class with particular regard to users in the Internet, i.e., pro means "favor" and net means network, widely used as a reference to the Internet (Rosnay 2006, p. 12).

of each institution; however, the evidence shows that cultural identities have made significant resistance to the integration of ICT in education (Chai et al. 2009; Correa et al. 2008). For instance, some Asian countries—e.g., China, Singapore, Hong Kong, Taiwan, India, Thailand, with strong cultural identities have chosen to develop their own Learning Management Systems (e.g., due to the conflict of languages) revealing, however, quite similar technological capabilities comparing with more sophisticated tools used in the Western countries (Zhang and Wang 2005).

Nevertheless, one of the purposes of this book intends to develop a critical reflection and sufficient depth about the educational process (as a conscious, complex, interactive, self-organized, and dynamic process), in the context of the digital era. Here, it is important to emphasize that the general outline of the book does not intend to express a technical conception around the theme of technological knowledge only, but also to understand the various "intelligent" interactions from some theoretical assumptions, proposing a broader approach in an epistemological perspective and not limited only to the subject of the emerging technological illiteracy. Consistent with the literature review, it seems crucial to discuss the multiple challenges and opportunities that currently are placed on institutions of higher education, concerning adoption and development of online teaching and learning systems (Brooks et al. 2006; Simonson 2005).

Using the metaphor of a journey, this book embarks from the aforementioned roots, in order to better understand the needs of users in intelligent online learning environments (iOLEs), in particular on the Learning Management System (LMS) Moodle, in the context of higher education and training. Thus, primarily online environments issues are discussed, assuming that online teaching and learning can be expressed at different levels, with different methodologies and different systems, inherent to each community of practice. In this vein, the main motivation of this book is to better comprehend an academic community and simultaneously to decode the dynamics of interactions led by the beliefs of the users toward an intelligent LMS (*i*LMS) within the context of b-learning.

First of all, with regard to the purposes of the book, and in order to enhance the online learning-teaching quality process toward intelligent b-learning, the following research questions served as a general guide:

- What is the user's perception of OLEs?
- Are users (students and teachers) satisfied and motivated to use the LMS Moodle?
- What strategies and tools have been used in the LMS Moodle?
- What perception and knowledge users have about the use of Web 2.0 tools?
- What instructional tools/strategies were used in LMS Moodle and could be incorporated toward the inclusive b-learning concept?
- Can the quality of interaction (QoI) of the users of the LMS Moodle contribute to the efficiency of the b-learning modality?

Consequently, the following three major aims of this book were set:

1. Contribute to the development of a conceptual, cultural, educational, and innovative perspective, around the OLEs, as well as analyze the potential/constraints of Web 2.0 communication tools in the context of higher education and training;
2. Characterize the process of online instruction through the thought and action of the users of the LMS Moodle in the b-learning context;
3. Contribute to educational improvement on teaching practice supported in the LMS Moodle, as well as provide new tools, perhaps more suited to future models, based on the users' QoI.

Additionally, the following five principal goals were considered:

1. Discuss conceptual assumptions that fit the thinking of teachers and students in the use of OLE in (higher) education and training;
2. Examine some international situations and trends in distance learning and the use of resources supported by ICT;
3. Identify the profiles and the main needs of users of a LMS Moodle of a public institution under b-learning modality;
4. Develop, validate, and apply efficient modeling based on both fundamentals of fuzzy inference systems and QoI of the users of the LMS Moodle;
5. Discuss the extension means and pathways from the typical form of LMS to the *i*LMS, touching issues like inclusiveness and affectiveness.

Considering the overall organization of the present book, structured around a series of cases studies at a public higher education institution, four distinct parts with corresponding chapters were articulated. In particular:

- Part I (Chaps. 1–3): *Review of Literature: From Macro to Micro Intelligent Point of View*. Based on current literature for the development of OLEs, some current issues of the process of teaching and learning in the digital age are characterized, analyzed, and reflected mainly upon potentialities and constraints that Web 2.0 communication tools can offer in an educational context.
- Part II (Chaps. 4–6): *Blending Quantitative and Qualitative Methods: Triangulation as a State of Mind*. This part describes ways of data collection and analysis, pointing out the central technical and methodological procedures followed.
- Part III (Chaps. 7–11): *The Art and Science of a Case Study in Higher Education: Towards a Pro-Intelligent System*. This part consists of five chapters, revealing characteristic examples of research case studies developed, bearing in mind the potential of intelligent systems.
- Part IV (Chaps. 12–13): *Overall Landscape*. This final part is a holistic and general discussion, articulated and framed with the literature review and the outcomes of the approaches previously presented, leading to the closure of the book with general conclusions and probing further thoughts, leaving ample space for emancipated critical reflections on *i*LMS and the intelligence of the

ICT-based educational approaches, in general, followed or to be followed in the future.

The proliferation of LMSs and supporting technologies made a definite impact on teaching methodologies. In a functional equilibrium of the two parts of the equation, faculty needs to master new ICT-based technologies, whereas software developers should be able to accommodate best educational practices and methodologies. This is why this book places the concept of converging toward *i*LMS within the b-learning context, incorporating socio-constructivist pedagogy, active, collaborative, mobile, inclusive, and affective online learning, with personalized attention to all course participants.

We hope that this book will prove to be a functional scaffold for effectively approaching *i*LMS issues, integrating data analysis and modeling techniques with the identification of users' trends, profiles, and QoI in the area of online education.

Let the journey begin!

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Contents

Part III The Art and Science of a Case Study in Higher Education: Towards a Pro-Intelligent System

Part IV Overall Landscape

Acronyms

CK	Content Knowledge
CMS	Course Management System
CoI	Communities of Inquiry
CoP	Communities of Practice
DE	Distance Education
EU4ALL	European Unified Approach for Accessible Lifelong Learning
FAQ	Frequently Asked Questions
FLOSS	Free/Libre and Open Source
FL	Fuzzy Logic
FIS	Fuzzy Inference System
HEI	Higher Education Institution
HE	Higher Education
HCI	Human-Computer Interaction
iLANDS	innovation, Learning, Achieving, Networking, Diversity, Society
iLMS	intelligent Learning Management System
KBC	Knowledge Building Community
LMS	Learning Management System
MOOCs	Massive Open Online Courses
MOODLE	Modular Object Oriented Dynamic Learning Environment
MUVEs	Multi User Virtual Environments
NML	New Millennium Learners
OLE	Online Learning Environment
PBL	Problem-Based Learning
PLE	Personal Learning Environment
PK	Pedagogical Knowledge
ROI	Return on Investment
SCORM	Sharable Content Object Reference Model
SL	Second Life
SLOODLE	Simulation Linked Object Oriented Dynamic Learning Environment
SNS	Social Networking Services

SWOT	Strengths, Weaknesses, Opportunities, Threats
TK	Technological Knowledge
TPACK	Technological Pedagogical Content Knowledge
VLE	Virtual Learning Environment
WWW	World Wide Web

Part I
Review of Literature: From Macro to Micro Intelligent Point of View

Chapter 1
E-Learning Exequibility in the Information and Knowledge Society

1.1 Introduction

This chapter aims to place the focus upon some current changes/trends in educational practice of Information and Knowledge Society and, simultaneously, examine the integration of Information and Communication Technologies (ICTs) in multiple contexts.

From a macro perspective, according to Pérez "We run very fast but do not know to where"[1] (Pérez 2000, p. 36). The phenomenon of globalization, as well as cultural-economic metamorphosis phenomena, has been marked by a global capitalism and it is directly linked to information networks that mainly focus on innovation, creativity, and flexibility (Rao 2001; Saarenketo et al. 2008). Although technology, in general, will not lead us to an information *utopia,*[2] from the context of the emerging Information Society, the availability of all information to anyone, anytime, anywhere comes to the foreground as an important need; here, the role of Education should be assumed as a factor of social equality, personal development and understood as an elementary right. Thus, in a global perspective, the Multicultural Society (i.e., pro-pluralistic society) (Banks et al. 2009; Brewer 2009), should be perceived as a means to promote social inclusion, bearing in mind the distribution of capital, embracing education without exclusion, respecting equality and equal opportunities, eliminating inequalities and searching for new ideas and opportunities according to human needs (Pérez Maya 2008). Therefore, it is important to underline that: "Culture here is seen as shared habits, values, memories and beliefs that unique a group of people and make communications between and among them easier" (Marchessou 2005); this can mean that in all societies there are different/multiple ways to communicate and (modes of) work, stimulating, in general, an recently increase of the designated *teleworkers* (Mustafa and Gold 2012). The concept of telework combined with the technology opportunities can bring immediate (positive) consequences in issues of productivity and

[1] Authors' translation.

[2] In a restricted sense, the concept of utopia must be understood as the best for all of us, i.e., the best imaginable world for each of us (Nozick 1974, p. 298).

S. B. Dias et al., *Towards an Intelligent Learning Management System Under Blended Learning*, Intelligent Systems Reference Library 59, DOI: 10.1007/978-3-319-02078-5_1,

global competitiveness. Consistent with this trend, the paradigm seems to no longer focus on information accessibility, but on managing the large amount of information that is nowadays available to anyone. On the other hand, the *information overload*, in a more general sense, can reflect a significant cognitive problem if individuals' skills are not enough to select important/superfluous information; here, education quality is regarded more than simply having information, i.e., is openly related with the construction of knowledge, lifestyles, attitudes and principles (Kings et al. 2008). From this perspective, the "Methodology and Social Impact of Information and Communication Technologies in America" (MISTICA) project, supported by online collaborative environments, also underlines the following idea (Pimenta and Barnola 2004):

> MISTICA has experimented with a methodology for coordinating virtual communities, one that combines information and communications resources so as to offer solutions to linguistic obstacles, reduce information overload and accommodate distance participation in face-to-face-meetings (p. 389).

Actually, if efficiently used, ICTs can play a key role in supporting immediate needs of the (online) learning environments; however, many educational institutions need to incorporate technology tools more adapted to reality, because without this conscience, probably will not be able to educate citizens prepared to the near-future.

Over the last decade, education and training are systematically considered as the elementary vectors of identity, social integration and personal achievement (European Commission 1995; European Council 2009), and, simultaneously, essential issues to the development of today's knowledge society and global economy (e.g., using collaborative strategies/frameworks for developing countries). Competency-based education and training programs, previously acquired of different institutional education system or in a more informal way, play a very important role to guarantee the future of the individuals and self-realization. However, for this purpose two crucial issues should be examined/re-approached, namely: students' quality of education (e.g., through the use of social networks in favor of a more flexible learning) and teachers' quality of training (Marcelo 2002; Wheeler and Wheeler 2009). Indeed, ICTs tend to be mainly responsible for various changes, for instance, in modes of interpersonal communication, in ways of understanding of knowledge/learning, as well as the concept of relationships, lifestyles and identity (Adell 1997; Aviram 2002; Castells 2011; Kim et al. 2011; Watson 2001). From these recent ICT-based movements of (r)evolution, is possible to assume that Society, globally speaking, is suffering a complex and tremendous process of transformation, influencing, inevitably, the way people work, communicate, learn and (self-) organize.

Furthermore, it is important to reinforce the idea that the Information Society should be seen as a Society mostly dedicated to learning and, in particular, to *Lifelong Learning* (LLL) (Petit and Soete 2001; Plomp 2013). Similarly, several trends and challenges are affecting the future of learning in a Knowledge-based

Society (Punie and Cabrera 2005) by changing consumer's habits and citizens' way of living, in general (Pérez 2000).

At a micro (educational process) level of analysis, a recent shift can easily be perceived from a didactic tripod, i.e., discipline, teachers and students, to a complex interaction network, which incorporates a new element—the *media* (Duchâteau 1996), allowing new ways of teaching and learning (Pérez 2000; Thomas and Thomas 2012). On the other hand, at a meso-level (institutional issues), these changes, fortunately, can be understood as real opportunities to rethink/readjust instructional approaches in a more flexible and adaptable way, considering individual students' needs. However, in a cyber (space) culture era, the key to promote faculty educational innovation lies in strongly supporting the reexamination of the concept of education (Bayne and Land 2005). As a consequence, and in line with other authors, a renewed pedagogy/methodology and practices are required (Adell 1997; Lévy 2001; Okada and Ferreira 2012). In addition, according to Beetham and Sharpe (2007): "we must acknowledge that pedagogy needs to be 're-done' at the same time as it needs to be 're-thought'" (p. 3). After all, pedagogy is an essential dialogue between teaching and learning. In order to encourage personal and intellectual students' development, teachers of the twenty-first century must be able to present characteristics and personality traits such as (Pérez 2000; Saavedra and Opfer 2012): adaptability to new circumstances, initiative, self-esteem, sociability, discipline, resistance to frustration, intellectual and emotional maturity, teamwork capability, verbal flexibility, creativity, empathy, and ability to motivate.

In addition, according to some authors, from a Problem-based Learning (PBL) approach, *knowledge worker* (in general, seen as a teacher) can develop an enriched learning environment that allows students to perform—individual and collective—tasks under constant supervision of a *teacher-tutor* (Lin et al. 1996; Marcelo 2002; Savery 2006). At the same time, based on a constructivist interpretation, teacher-tutor plays a (pro) active role during the teaching and learning process, as noted by Savery and Duffy (1996):

> (…) learner's 'puzzlement' as being the stimulus and organizer for learning, since this more readily suggests both intellectual and pragmatic goals for learning (…) Knowledge evolves through social negotiation and through the evaluation of the viability of individual understandings (p. 136).

These approaches clearly suggest that learning occurs from problems or situations that stimulate doubt or questioning to further enhance critical thinking and creativity that are subjacent to the (co) construction of knowledge. In a further step, Visser (2005) gives the following perspective:

> In Web-based distance education, the mentor often also serves as a filter for information and knowledge, such that information gathered elsewhere is assessed for validity and relevance. Mentors possessing rich subject matter expertise and critical thinking skills may serve the dual role of raising learner awareness of the importance of identifying valid sources of information and validating actual sources that are identified by learners (pp. 296–297).

The so called *distributed knowledge*, created by technology (in Web-based distance education environments), has allowed many teachers, which in most cases are widely geographically distributed, to develop virtual communities, sharing information and knowledge with peers (Carnoy 2001). More recent evidence suggests that improving an individual's degree of adaptability, such as optimism and positive attitude, to technology could increase knowledge-sharing intentions in virtual communities (Hung and Cheng 2013). In turn, the explosive growth of Internet (also described as a psychological phenomenon, i.e., *cyberpsychology*) is clearly changing the way people think, read, remember, learn and, in general, theirs' daily lives (Denissen et al. 2010); it also can simultaneously enhance imagination, as well as logical and abstract inferences of human thought (and knowledge) (Aviram 2002). Besides, from a *Web-Based Instruction* (WBI) perspective, students have currently the opportunity to take advantage of new (multifunctional) learning materials that allow them to learn, discover, produce, and synthesize knowledge differently, i.e., a key to promoting critical/abstract thinking, participation or collective work (Bonk and Reynolds 1997). Furthermore, complementarily to the capability to learn (acquisition), different intelligence capabilities, such as technological innovation, leadership, decision-making and ICT use seem to emerge, in order to flexibly respond to the challenges of today's society and educational institutions, in general (Berrocoso 2009; Marcelo 2002). Interestingly enough, the recent book *iLeadership for a New Generation* by Elliot and Simon (2011) also explores the relationship between leadership and innovation from concepts to reality; in other words:

> One of the most radioactive isotopes in Steve's powerful charisma is the fact that he has convinced his workers he will commit to innovations. That's what elicits innovation and creates a culture of innovation (pp. 161–162).

More specifically, Bates and Sangrà (2011) highlight the importance of *charismatic leadership* and *collective leadership*, both through the process of the technology integration and viewed as an institutional response or a strategic adaptation. Society's values/expectations have changed across time. Nowadays, different attributes of culture and education are appreciated, along with particular capabilities/skills, such as creativity/imagination, innovation, self-actualization/refreshing, communication and adaptation. Furthermore, Lévy (2001) adds that: "a characteristic of the civilization engendered by digital networks in general, also enables us to appreciate the specificity of the artistic genres unique to cyberculture" (p. 117). On the other hand, the adaptation concerning learning resources and technology seems to require less effort from today's students (*digital natives*) than from today's teachers (*digital immigrants*) (Prensky 2001, 2010). In a complementary perspective, considering the digital native-digital immigrant model proposed by Prensky (2001) to describe the generation gap separating today's students from their teachers, Prensky (2009) reported that:

> It's time for education leaders to raise their heads above the daily grind and observe the new landscape that's emerging. Recognizing and analyzing its characteristics will help define the education leadership with which we should be providing our students, both now and in the coming decades. Times have changed (p. 306).

Thus, *techno-pedagogical* innovations, in the use/integration of ICT, are clearly associated with models that include representations/visions, skills/resources, attitudes and practices of their social actors, as well as the negotiation process of teaching-learning (Peraya and Viens 2005; Wenger 1998). From this (digital) perspective, considering all previous aspects mentioned earlier and their interconnections with the use of ICT, it is possible to say that the social commitment and flexibility (in terms of time, space, knowledge, effort, relationships and work) of all stakeholders in the educational process (meso-level), and in the society (macro-level) in general, seem to represent key elements; the latter simultaneously create important conditions to promote autonomous work, abstract thinking, creativity, networking, and collaborative intelligence. Unequivocally, based on these implicitly and explicitly opportunities/challenges, the current Information and Knowledge Society has accompanied an increase of different and, perhaps, more adapted educational solutions, in particular, distinct delivery modes of e-learning. Moreover, in a global scale, the World Wide Web (WWW) can be seen as an educational tool that combines/integrates text, audio and video, allowing different forms of interaction and collaboration between users. As a consequence, more instructors, teachers and educational institutions have used the WWW as an important resource to develop online courses (Mason 1998). After all, education and training through WWW are commonly understood as electronic (e-) learning. In this context, some global e-learning advantages/disadvantages are exposed (Cação and Dias 2003; Lima and Capitão 2003) below:

Advantages

- Effectiveness and efficacy
- Ease of use and accessibility
- Standards and uniformity
- Interaction and interactivity
- Speediness and economy

Disadvantages

- Pedagogical issues
- Technical problems
- Certification difficulties
- Sociocultural bias
- Universities' appreciations/depreciations

At the same time, using micro-level of analysis (student–teacher interaction), is essential to understand that (Visser 2005):

> Students in web-based distance education programs would also be negatively affected if mentors are tasked with a job that is larger than they can reasonably be expected to handle. If the mentors are overburdened with some of the tasks they are expected to carry out (answering technical questions, responding to individual inquiries, motivating students, providing continuous feedback, etc.), other tasks will fall to the wayside, and the student will only receive a portion of the support and guidance that is needed (p. 298).

In general, however, more recent studies, mainly based on Strengths-Weaknesses-Opportunities-Threats (SWOT) analysis, have revealed various and different types of intervention models, recommendations, as well as a significant concern to understand the quality of e-learning, in terms of the context-specific needs (Bates and Sangrà 2011; Bramble et al. 2008; Elgort 2005; Marshall and Mitchell 2005; Mohammad 2010; Morgan 2001; Wadhwa 2006).

To further elaborate on the e-learning, a description of the common models engaged within the online learning environments (OLEs) follows.

1.2 Common Models of OLEs

From the variety of theoretical frameworks which coexist in the field of OLEs, the ones that have theoretical importance in the field, commonly used, and influence other online learning models are only considered here and listed in Table 1.1.

1.2.1 OLE#1

The first online learning model examined here is the one proposed by Salmon (2000), which epitomizes the role of e-moderator (teacher, facilitator) during the process of construction of knowledge in OLEs. The skills development assumes the immersion of the tutor in the learning environment and, consequently, the importance of training in online context. In this case, the author proposes a comprehensive synthesis of the skills of the e-tutor, connecting two types of variables: (a) the *characteristics*, i.e., understanding the online process, technical skills, online communication skills, mastery of contents and personal skills, and (b) the *qualities*, i.e., confidence, constructive spirit, ability to stimulate the

Table 1.1 Summary of the considered OLEs

Model #	Model concept(s)	Authors' references
OLE#1	E-moderating	(Salmon 2000)
OLE#2	Types of interaction	(Anderson 2004)
OLE#3	Learning ecology and connectivism	(Siemens 2006)
OLE#4	Technological pedagogical content knowledge	(Mishra and Koehler 2006)
OLE#5	Social media in classroom	(Bosman and Zagenczyk 2011)
OLE#6	Integration of technology, organization, pedagogy	(Bates and Sangrà 2011)
OLE#7	Learning 2.0 iLANDS	(Redecker et al. 2009)

development, ability to share knowledge and creativity. Regarding the level of teacher's intervention in OLEs, this model is structured in five steps, that is:

1. *Access and Motivation* (first contact with the learning environment): it is suggested that students develop during this stage the emotional and social capacity to learn together online, as well as have access to the system and use the discussion forums. The continuity of this process depends on the individual access and motivation of the students in the use of the OLE.
2. *Online socialization* (construction of learning community): this step is characterized by an individual's integration with other elements of the group, resulting in a learning community, consisting of active and interactive *e-activities*. It is intended to gradually build a virtual identity within the group culture, as well as familiarizing people with the online environment that will facilitate the exchange and the sharing of information. The teacher should provide activities that take into account the individual differences of each student, in order to foster a multicultural learning context.
3. *Information exchange* (exchange of information between the elements of the community): the teacher at this stage appears as *e-moderator*, creating activities (discussion forums, online discussions) that enable effective information sharing between all stakeholders. Mutual and cooperative work among the students is essential at this stage. However, the teacher must create methodologies and strategies which enable him/her to effectively manage the way each student accesses the information provided and his/her responsiveness.
4. *Knowledge construction* (the beginning of interaction processes): it is in this step that e-activities are developed, in order to promote the process of thinking and interacting online. Having acquired the information-sharing phase, students are expected to start the construction of knowledge, which leads them to develop skills with regard to critical thinking, creativity and practical thinking. It is desirable that the faculty develops independent and cooperative e-activities, without showing recipes for the problems, but rather stimulating autonomous learning in students.
5. *Development* (constructivist learning strategies): in this phase the students are prepared to self-manage and enhance their learning process. Here, the teacher should plan e-activities that stimulate reflective and creative thinking. In turn, students must be able to support their colleagues in collaborative work, reaching individual objectives, as well as assess the technologies, which they were provided during the online learning process.

In short, this model clearly shows the *multifaceted* role of the *e-moderator,* requiring creative qualities to construct appropriate and varied e-activities in a gradual increase of the intensity of interaction. Also, is perceptible that students, at each step, need to develop technical skills to smoothly advance to the next one.

1.2.2 OLE#2

The second model considered here is Anderson's online pedagogical model (Anderson 2004); it is based on three types of interactions presented by Moore (1989), i.e., student–student interaction, teacher-student interaction, and student-content interaction. Anderson's OLE primarily focuses on independent and collaborative learning, highlighting the importance of the role of the interaction. It is also known as a model of e-learning, which allows structuring and organizing online learning through six particular types of interaction, i.e., teacher-content, content-student, student–student, student–teacher, student–content and content–content. Indeed, the two identified actors (teacher and student) interact with each other and with the contents. During this interaction a wide variety of activities (synchronous and asynchronous) can be used, based on the Internet (e.g., audio, video, conferencing, chats, and virtual worlds). These environments are particularly enriched, promoting the development of social skills, collaborative work, as well as at the level of interpersonal relationships between the participants (Anderson 2004).

This model can be interpreted and analyzed in two separate parts. In the first part, students can interact with the content that is available in various formats (especially with Web tools), or they can choose to have their learning in a sequential way, i.e., guided and evaluated with the help of the teacher. This interaction can be seen as a community that is mainly stimulated by the use of various e-activities, synchronously or asynchronously (e.g., video, audio, forums, videoconferencing, chats, virtual interactions, etc.), supporting social interaction, collaborative learning content and the development of interpersonal relationships. In the second part, learning tools are based on independent learning (e.g., tutorials, simulations and games, virtual labs, e-books); however, even if guided to independent study, the students continue to be followed, since they share the same workspace with other colleagues, or peers-to-peers connections that ensure permanent cooperation and communication interfaces.

1.2.3 OLE#3

The Siemens learning model (Siemens 2006) offers an ecological vision of learning, i.e., the *Learning Ecology,* with the premise that the search of knowledge is a constant across life, in other words: "we keep looking until we find people, tools, content, and processes that assist us in solving problems" (Siemens 2006, p. 33). This author introduces the theory of *connectivism*, which is based on the understanding of the learning process as a process of networking. The latter describes how learning can be developed in the digital age, standing behind the idea that information flows at high velocity, difficulting its processing and interpretation (information overload). Indeed, the connectivity is understood as the

integration of some principles that are explored by chaos, social networks, by the theories of complexity and self-organization. In the *Knowing Knowledge* book, the author seeks to clarify the multifaceted and multidimensional atmosphere of learning, considering four specific domains, namely: *transmission, emergency, acquisition,* and *accretion* (Siemens 2006, p.33). From this scenario, the Internet can be seen as a learning ecology with different potentials, revealing itself a center of creative chaos, such as Siemens (2006) clarifies: "Connectivism is the integration of principles explored by chaos, network, complexity, and self-organization theories" (p. 30).

Connectivism must still take into account the following principles: (i) learning and knowledge require diversity of opinions; (ii) learning is a network formation process of connecting specialized nodes or information sources; (iii) knowledge rests in networks; (iv) knowledge may reside in non-human appliances; (v) capacity to know more is more critical than what is currently known; (vi) learning and knowing are constant, ongoing processes; (vii) ability to see connections and recognize patterns and make sense between fields, ideas and concepts is the core skill for individuals; (viii) currency is the intent of all connectivist learning activities; and (ix) decision-making process is learning (Siemens 2006).

1.2.4 OLE#4

The fourth perspective presented here refers to the term Technological Pedagogical Content Knowledge (TPACK)—based on an extension of Shulman's model (1986), which supports the assumptions that teaching is a mixture of art and science and, on the other hand, teacher's knowledge represents a mixture between the content and pedagogy (Pedagogical Content Knowledge)—is presented as a theoretical model that describes the responsibilities of the teacher concerning the integration of ICT and the use of a Learning Management System (LMS) (Mishra and Koehler 2006; Schmidt et al. 2009).

This model (Mishra and Koehler 2006) focuses on the interaction and the complexities of different kinds of knowledge: content, pedagogy and technology. In turn, the concept of TPACK as being the result of the intersection of knowledge from a teacher at three levels, namely: content (Curriculum Content Knowledge-CK), teaching methods (Pedagogical Knowledge-PK), and technological skills (Technological Knowledge-TK). Additionally, this model integrates three different components of knowledge: (i) *Pedagogical Content Knowledge*; (ii) *Technological Content Knowledge*, and (iii) *Technological Pedagogical Knowledge*. Several researchers have used the TPACK model to analyze some cases of quality in training and further training in the teachers and in finding the ways to integrate technology in their teaching methodology (Lim et al. 2010; Niess 2005). In practice, applying the TPACK model is not considered a simple task; several researchers, however, have developed tools/instruments to evaluate the use of TPACK by teachers (Schmidt et al. 2009), in order to understand how to act with

regard to the training of teachers and TPACK constructs. Some examples of TPACK evaluation efforts refer to the work of: Schmidt et al. (2009)—who performed questionnaires in different countries and in different groups of teachers (initial and continuing training); Burgoyne (2010)—who aimed to evaluate the teachers' perceptions about self-efficacy; and Groth et al. (2009)—who have adopted a more qualitative approach. Based on the relevant literature, it is also possible to verify other related issues, such as the analysis of activity types that will be offered to teachers in training to the development of the TPACK, in order to integrate technology in education. More specifically, Harris and Hofer (2009), based on the TPACK concept, introduced a taxonomy organized into seven types of learning activities for the use of ICTs, i.e.: *knowledge building* (e.g., reading texts, presentations, group discussion, debates), *knowledge convergent* (e.g., answer questions, create maps, complete tables), *written essays* (e.g., write a report, create a diary), *visual divergent knowledge expression* (e.g., create an illustrated map, create an image), *conceptual divergent knowledge expression* (e.g., develop knowledge on the Web, ask questions), *product-oriented divergent knowledge expression* (e.g., create a model, create a movie, produce a newspaper), *participatory divergent knowledge expression* (e.g., make a presentation). In any case, all these activities can be combined during the planning of the lesson, accommodating students' needs and interests/motivations.

1.2.5 OLE#5

Nowadays, social media tend to be increasingly associated with different mechanisms to meet and interact with people. However, *social media* can represent an important working tool to be socially and consciously constructed in an educational vision.

In general, the Bosman-Zagenczyk online learning model presented here (Bosman and Zagenczyk 2011) is based on the use of different social media tools following the different levels of the taxonomy of Benjamin (Bloom 1956). Indeed, Bloom's taxonomy and adjacent hierarchical classification of learning objectives seem to be an important academic contribution, in particular to the faculty that appreciates social resources, in order to stimulate higher-order thinking of the students. From a SWOT-based analysis, this conceptual framework aims to integrate the different social media in the classroom (Bosman and Zagenczyk 2011). Nevertheless, in order to facilitate the interpretation of this model, some authors point out different tools that can adapt to different levels of learning (Bunzel 2010; Hayman 2007; Prensky 2010; Solomon and Schrum 2007; Waycott et al. 2010). Considering the latter perspectives, Bosman and Zagenczyk (2011) defined six levels that should be included in the educational process, i.e.:

- *Level 1—Remembering with Social Bookmarking* (remember relevant knowledge of long-term memory through e.g., Delicious, Google, Diigo tools);

- *Level 2—Understanding With Social Blogging* (realize the meaning of oral communication, written messages or graphics through e.g., Edublogs, Blogwordpress, Google Blogger);
- *Level 3—Applying with Social File Sharing* (apply certain procedure in a specific situation using e.g., Moodle, Google Docs, Wikis);
- *Level 4—Analyzing with Social Collaboration* (analyze how the parts relate to each other in a global structure through e.g., DimDim, Skype, BigBlue Button tools);
- *Level 5—Evaluating with Social Decision Making* (evaluate on the basis of criteria or standards defined, using e.g., UserVoice, Doodle, Kluster); and
- *Level 6—Creating with Social Creativity Sharing* (collect elements to create a whole or create a unique product using e.g., YouTube, Flickr, Scribd, Whiteboard).

In addition, the authors also add that the affective/emotional domain (in particular with respect to communication and building relationships with colleagues, friends, and family) can also be potentiated through the use of social media resources (e.g., Facebook, SecondLife, LinkedIn, Ning).

1.2.6 OLE#6

In 2008, based on key vectors—technology, organization and pedagogy—Sangrà revealed the TOPs online learning model (Sangrà 2008), as a triangle of factors that are closely related to each other in a symbiotic way. More specifically, between 2004 and 2005, from a SWOT-based analysis, five European case studies were examined, namely: University of Milan (UNIMI), University of A Corunã (UDC), University of Alicante (UA), University of Rovira i Virgili (URV) and Open University of Catalonia (UOC), enabling to observe how some universities have integrated ICT into their activities. In general, the SWOT technique revealed a diagnosis of the situation of the internal and external reality of each institution.

However, a step forward was done when Bates and Sangrà, in 2011, showed the results (mainly qualitative) from 11 individual case studies, focusing at the richness of interconnections between the various strategies, visions, policies, and institutional contexts of each institution. To this end, all aforementioned European universities were considered (i.e., UNIMI, UDC, UA, URV and UOC) adding one more European university [i.e., Open University of Portugal (UAb)] and five North American institutions [specifically Virginia Tech (VT), University of British Columbia (UBC), University of Central Florida (UCF), Southern Alberta Institute of Technology (SAIT) and Collège Boréal (CB)]. In short, seven campus-based universities, two community colleges and two open universities were examined, combining analysis of documents, personal interviews, focus groups (including faculty members and students) and statistical data collection (e.g., number of students enrolled in online courses) (Bates and Sangrà 2011). In summary, Bates

and Sangrà's online learning model clearly underlines the fact that successful technology integration requires equal attention to following three main components:

- pedagogy (teaching methods)
- technology and
- organization

Also, they point out that it is vital to change the circumstances, giving special attention to organizational and cultural issues. Training for instructors/managers and institutional incentives/strategies are also considered essential requirements to create an online environment that encourages change and innovation in teaching and learning.

1.2.7 OLE#7

The Redecker et al. (2009) online learning model is the final model discussed here; it introduces the concept of Learning 2.0 *i*LANDS, focusing particular in areas in which social computing applications support innovation in learning. From an in-depth analysis of existing practices, and considering the social computing concept for learning as a multidimensional and dynamic phenomenon (in a constant evolution), the following distinct areas (that form the abbreviation of *i*LANDS) were distinguished by the authors (Redecker et al. 2009, p.42):

- Learning (L)—the Web 2.0 tools (social computing) can be used as a support in the implementation of educational strategies that facilitate/improve the process of learning and the transformation of knowledge, customize the learning processes, and allow the progress of learning to respect the student's individual pace;
- Achieving (A)—the social computing can contribute to learning outcomes and motivation of students (individually and adapted) vis-à-vis their own learning needs, contributing to the development of social and cognitive skills (e.g., reflection and metacognition).
- Networking (N)—the social computing can be seen as an instrument of communication between students and teachers and student–teacher dialectic, which supports the sharing of knowledge and resources in different networks, facilitates community building and provides collaborative (multi-) platforms.
- Embracing Diversity (D)—the Web 2.0 can be seen as a means of integration of learning in a wider community, allowing the achievement of virtual knowledge of other age groups and professionals, with different cultures and experiences, sharing experiences, opening new channels to build knowledge and skills development; and
- Opening up to Society (S)—the Web 2.0 can be used to develop an institutional learning accessible and transparent to all members of society.

Generally, moving from the core to the peripheral logic, these five areas seem to give new spaces for innovation (*i*) in learning (LANDS). Each dimension (area) specifies different approaches, strategies and objectives. This model aims, essentially, to show how social computing is used in formal educational contexts, and simultaneously, how social computing tools are used to support learning processes, distinguishing technological, organizational and pedagogical innovation as the main enablers of transformation.

1.3 Overall Perspective

ICT and the rapidly evolving knowledge society pose a challenge to educators and stakeholders. As presented in the previous subsections, different proposals and rhetoric for addressing the future have been introduced. Indicative concepts, amongst others, include lifelong learning, distance education, connectivism, constructivism, e-moderation, student-centered learning, digital divides, and OLEs.

Nowadays, knowledge in society underlines an explosion of information and knowledge and imposes much faster pace of change in what is known and what is institutionalized. In this vein, young people need adaptation skills and access to on-demand information systems. In fact, the explosion of information implies using systems that require new skills for accessing, organizing, and retrieving information. The scope of ICT is dynamic and continuously changes with the creation of new technologies. Daily invention of new technologies provides a major challenge to implementation of ICT-based educational strategies. It is imperative to track such developments because not only do they change the skill requirements for students, but also they impact society and change research priorities for research on ICT and education internationally.

One should infer from this chapter that progress harnessing of technology for education requires progress in understanding the tools and their context, both educational and social. For that understanding to go forward effectively requires increments in theory and research. The theory part includes refining the concepts and specifying the underlying influences within the overall system. The concepts of the information and knowledge society are central to that understanding. In particular, we need to know much more about knowledge: how best to define it, how to utilize students' prior knowledge in the learning process, how to manage knowledge in organizational environments, how to let it guide the construction of assessments, and so on. The procedural pathway towards such direction is analytically presented in the succeeding chapters.

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Chapter 2
Coresponsibility on Negotiation Process and Issues in Blended Instruction

2.1 Introduction

This chapter underlines the teaching-learning process mediated by technologies, along with the main theoretical assumptions regarding the development of OLEs, viewed through the concepts of multitasking, learning communities, focusing on the coresponsibility of the stakeholders on negotiation process within a blended learning environment.

Through the Internet, a lot of information tends to allow the interconnection among millions of people, institutions, companies, and education/research centers (Castells 2011). In this way, information networks have revealed a huge potential, enabling infinite communication between people, and eliminating the time and spatial constraints and barriers of identity and social levels. In the Information and Knowledge Society, space and time are no longer constraints of social interaction and technological innovations; they, however, seem to require an increasingly qualified working model, multifaceted and collaborative in the multiple forms of educational organization.

Although multitasking is not considered a novel concept, it has received increasing attention in recent years with the development of media and technologies, in general. Possibly, as a result of this phenomenon, psychologists and neuroscientists have been fascinated, for instance, with the limits of human information-processing; however, here, the main focus is predominantly on the "multitasking generation". In the context of the younger generation, several authors have examined and discussed, since the end of the last century, different characteristics that tend to characterize the same phenomenon; that is, the evidence of digital technology as an integral part of the daily life of the students of the twenty-first century. In fact, the description of this phenomenon has given rise to different terminology, for example: Generation Nintendo (Guzdial and Soloway 2002), Net Generation (Hartman et al. 2005), Digikids, Instant Generation, Cyber Generation (Thieme 2006), Generation Next, Generation Z, Digital Generation (Tapscott 2009), Homo Zappiens (Veen and Vrakking 2006), Always On (Oblinger 2004), Neomillennial Learners (Dede 2005) New Millennium Learners (OECD

S. B. Dias et al., *Towards an Intelligent Learning Management System Under Blended Learning*, Intelligent Systems Reference Library 59, DOI: 10.1007/978-3-319-02078-5_2,

2008; Pedró 2006) or even Digital Natives (Prensky 2010). Each of these conceptualizations seeks to create a "tag" to identify the young generation on the basis of different related technology. Also, more recently, a multigenerational study demonstrated that Millennials (born between 1982 and 2001) were spending more time than Generation X (born between 1965 and 1976) and Baby Boomers (born between 1946–1964) on media-related active ties like Web surfing, texting and video games (Carrier et al. 2009). In brief, Millennials were more likely to multitask compared with the previous generations. In addition, some researchers have noted that the brains of our current generation adapt to the technology revolution in ways that are different than Baby Boomers and Generation X (Small and Vorgan 2008). In turn, Felder and Silverman (1988), reinforce that young people today tend to process the information in different ways. Hence, there is a need to adjust also the teaching methodologies used; in other words:

> Students preferentially take in and process information in different ways: by seeing and hearing, reflecting and acting, reasoning logically and intuitively, analyzing and visualizing, steadily and in fits and starts. Teaching methods also vary. Some instructors lecture, others demonstrate or lead students to self-discovery; some focus on principles and others on applications; some memory and de-emphasize others understanding (p. 674).

With regard to the visual dimension, in particular, Felder and Silverman (1988) stress that students obtain information essentially through visual images, e.g., figures, diagrams, graphs, schematics, movies and demos. In line, Oblinger and Oblinger (2005) reinforce this idea, in so far as they consider that this generation is influenced by the use of images, more than by environments that only resort to use texts. Yet, from the perspective of the authors, Net Generation clearly shows the importance of interaction, since they enjoy the fast transmission of information, and notoriously loses interest/attention in contexts of low interaction (Oblinger and Oblinger 2005). Prensky (2010), in his book *Teaching Digital Natives*, adds the following:

> By virtue of being born in digital age, our students are digital natives, by definition, but that doesn't mean they were ever taught everything (or anything, in some cases) about computers or other technologies, or that all of them learned on their own (p. 64).

Additionally, according to Pédro (2006), the New Millennium Learners (NML) are enthusiasts of the computers, creative on the use of technology and have a multifaceted agility in the "world" of digital tasks, featuring a wide variety of skills in the use of digital technology, able to perform multiple tasks simultaneously (e.g., watching TV, talking on the phone, and do homework at the same time). Hartman et al. (2005) associate this multitasking behaviour to carry out several activities at the same time, looking for constant communication, channels of interaction with the media and their own satisfaction through the handling of multifunction devices. In this sense, the quotation below expresses, in a way, how the digital media may be closely related to multitasking behavior (Dede 2005):

> (…) my teenage daughter 'does her homework' by simultaneously reading her textbook, listening to her MP3 player, receiving and sending email, utilizing her Web browser, and dialoguing with six of her classmates via instant messaging (p. 7).

Pedró (2006) connects NML with fundamental changes regarding the level of cultural practices and social values. For instance, the NML are less controlled by adults, family or teachers, since they have autonomy to select what they see and what they can transfer (e.g., downloads, uploads). However, Frand (2000) argues that this generation assumes the following ideas: (i) computers aren't considered to be technology; (ii) the Internet is better than television; (iii) multitasking is a way of life; and (iv) staying connected is essential. In addition, Pedró (2006) advances with the term *grasshopper mind* in order to characterize the behavior of NML, since they have a logical "jumpy" on ability to move from one subject to another, as well as on the speed of change in direction from front to back on a given subject. The intensive use of ICT tends to cause changes in the cognitive characteristics of the NML, namely in terms of their ability to concentrate and in need of immediate responses in the realization of multitasking. In other words (Pedró 2006):

> NML have grown up used to: (a) Accessing information mainly on non-printed, digital sources; (b) Giving priority to images, movement, and music over text; (c) Feeling at ease with multi-tasking processes; (d) Gaining knowledge by processing discontinued, non-linear information (p. 10).

From this perspective, daily life tends to be increasingly characterized by instant communication through the use of technologies that enable synchronous type communication (e.g., messenger, SMS, MSM). The immediate responses, as well as the fast reaction velocity, seem to be increasingly frequent and necessary in personal communication of individuals (Oblinger and Oblinger 2005; Pedró 2006). According to Foehr (2006), young teens seem to embrace multitasking as a way of life. For instance, many teenagers send text messages during the day while they are engaged in school and social events. In turn, American teenagers sent an average of 3146 text messages per month in 2009, i.e., about more than 10 messages every hour of the month that they are not sleeping or at school (Entner 2010). Curiously, according to Madden and Lenhart (2009), one in three teens between the ages of 16 and 17 assumed the use of text messaging while driving. Indeed, students choose to have learning experiences, such as "digital, connected, experiential, immediate, and social" and reveal to have preference for learning spaces "digital, mobile, independent, participatory, social learning-to-be, peer-to-peer, visual, and kinesthetic and real world" (Oblinger and Oblinger 2005). In 2008, a study developed by Conole et al. (2008), pointed out some changes in the use of technology for learning, suggesting the integration of eight fundamental aspects in the practices/policies of the institutions, namely: "pervasive, personalised, niche, adaptive, organised, transferable, time/space boundaries, working patterns, integrated" (pp. 521–522). In general, this approach aims to illustrate the fact that students can use ICT increasingly as a privileged means to develop their learning to communicate with teachers, colleagues, and/or experts. Also, the results

revealed that students use technology in varied ways, adapting the communication tools according to their individual needs/preferences and to share ideas, knowledge and, even, to verify their own evolution (Conole et al. 2008). In this scenario, Redecker et al. (2009), reinforces that the new generation of students clearly shows complex learning styles due to accessibility and flexibility in the use of digital resources. Compared with previous generations, these new students (Homo Zappiens generation) acquire more information through images and in a non-linear way for knowledge construction. Thus, the students of the twenty-first century tend to demonstrate the following characteristics (Redecker et al. 2009):

- Prefer multimedia environments,
- Are constantly connected with their peers and most of the time via online,
- Require multiple consecutive stimuli (to avoid boredom),
- Are impatient, needing constant feedback and be observed while performing the tasks,
- Are social and pragmatic,
- Focus on team spirit, and
- Adapt learning to your individual needs.

Consistent with the trend already described, Sharples et al. (2007), presented the mobile (*m-) learning* concept as: "the processes of coming to know through conversations across multiple contexts amongst people and personal interactive technologies" (p. 224). Here, the conversation process is seen as primary guide of learning. Indeed, the mobile resources used for conversation (mobile devices) and sociocultural context appears to be important for understanding how the m-learning can be integrated in education (Georgiev et al. 2004). This trend seems to be more noticeable in some academic contexts (e.g., Universitat Oberta of Catalunya, University of South Africa, Korea National Open University, Queensland University of Technology). This modality of learning seems to offer new ways to extend education to the context outside the classroom (informal contexts) and to interactions of everyday life. Bates and Sangrà (2011) add the following:

> Worldwide, more people have mobile phones than personal computers (…) The mobile technology has become more sophisticated, with larger, clearer screens, touch-controlled keyboards, and motion-controlled navigation, the potential for educational applications has also increased (p. 39).

Interestingly, in South Africa, taking into account the particular context and culture, great opportunities for the development of the modality of m-learning are being explored, specifically via short messaging systems, such as Visser and West (2005) explain:

> In distance education, SMS can be used for student support and for urgent messages. The tutor can send the student personal message such as 'For you to do' (13 characters) in the short form '4U2do' (5 characters) (pp. 132–133).

In fact, *mobility* and *ubiquity* of digital practices, namely mobile phones, networking, tend to be determinant characteristics of everyday life of young people also known as the "always on" generation (Oblinger 2004). Furthermore, the work carried out in wireless network, enables the mobility of students, making possible to be constantly connected (ubiquitous computing) (Dede 2005). In this scenario, more recent studies have associated m-learning with the *cloud computing* concept, emphasizing the promotion of m-learning in a more dynamic and flexible way (Christensen 2009; Gao and Zhai 2010). In other words (Gao and Zhai 2010):

> Cloud computing is the basic environmental and platform of future mobile learning and supports and promotes the development of mobile learning through 'cloud services'. But the mobile learning plays an important role in the information education, and becomes to a major choice in the school teaching, it also need the education technology workers to further research and discussion (p. 242).

General speaking, cloud computing systems are designed to provide services anytime and anywhere from any device (Dikaiakos et al. 2009; Kaufman 2009), and may, simultaneously, represent great educational potential (e.g., the reduction of costs) in various forms of e-learning (Al-Zoube 2009), as well as improve digital inclusion in the Information Society. According to Dikaiakos et al. (2009): "The key driving forces behind cloud computing are the ubiquity of broad-band and wireless networking, falling storage costs, and improvements in progressive Internet computing software" (p. 10). The authors suggest that the "cloud" can organize itself according to an approach which is restricted to a single organization or group (*private clouds*), available to the general public via the Internet (*public clouds*), or shared across multiple groups or organizations (*hybrid clouds*). It should also be noted that some issues relating to security, privacy and interoperability of data is identified as major constraints in integrating these systems (Bates and Sangrà 2011; Kaufman 2009; Mitchener 2008). In this sense, Bates and Sangrà (2011) underline the importance of the specific needs of each context by adding the following: "the concerns about cloud computing services disappearing if the hosting company goes bankrupt, and perceived difficulties in adapting services to specific local needs" (p. 29). In short, this generation can be identified through the occurrence of the following characteristics (Brown 2005):

- The use of webquests as a particular type of learning (learning by doing rather than listening),
- The multitasking phenomenon (the permanent use of technology accompanied by multiple stimuli),
- The need for immediate feedback, and
- The need for independence and involvement in the learning process.

In this way, the students of the twenty-first century tend to be autonomous in the selection of their learning styles, choose (most often) online readings, interactive multimedia presentations and group/collaborative work. In this sense, some perspectives have contributed to the emergence of different learning patterns,

reflecting, perhaps, a relevant impact on formal and informal learning process. Accordingly, Veen and Vrakking (2006) add:

> (…) this generation is the first generation that teaches their parents how to use the forum, how to use a mobile phone, and to do their telebanking and other online bookings, this was the first time we can notice 'inverse' education taking place, a phenomenon never seen before (p. 50).

In an intelligent way, Redecker et al. (2009, p. 24) identify and categorize some characteristics of the NML in the following six dimensions:

- *Society* (e.g., ubiquity of ICT, ease of access and use, information overload);
- *NML's ICT usage* (e.g., preference for electronic environments, multiple media usage, connected, always on);
- *Personal attitudes* (e.g., active involvement, constant engagement, very creative, expressive);
- *Cognitive patterns* (e.g., non-linear, less textual, less structured, multimodal, visual, dynamic representations, discontinuous, cognitive overload, distracted);
- *Working attitudes* (e.g., less fear of failure, instant gratification, impatient, surface oriented, multitasking);
- *Social attitudes* (e.g., extremely social, egocentric, need sense of security).

In summary, it is important to strategically take into account the advantages of multitasking phenomenon for effective learning gains rather than superficial entertainment gains. Effectively, NML are the first generation that born and grow with digital technologies and, therefore, tends to learn differently, mirroring a relevant opening to diversity, social differences and sharing information, in general. So, it seems prudent to say that these students (NML) expect, at the beginning, more interactive and efficient pedagogical approaches, rather than traditional classes (in one direction) or face-to-face (F2F) without link to ICTs.

2.2 Coresponsibility in the Negotiation Process

According to Wenger (1998), the emergence of *Communities of Practice* (CoP), i.e., groups of people who come informally together to learn, build and are responsible for the management of knowledge, can be seen as a real educational solution. From the community concept, the (co) production of knowledge embraced by users (user-producers) – *produsage* – has been supported by various Web 2.0 applications (e.g., blogs and wikis). In fact, other forms of interaction, gradually, arise, including the designated virtual communities. However, Kester et al. (2006) argue that for the process of social interaction in this ecosystem (in particular at the level of cooperation) it is necessary to take into account three factors: *continuity* - two individuals that interact with each other must interact at least a second time, in the future; *recognizability* - all individuals can identify each other; and *history* - all individuals may be aware of behaviors occurred in the past.

On the other hand, Garrison et al. (2000), consider that the creation of an online community of inquiry is the result of a learning process that occurs through the relationship of three key elements: (i) *social presence*, which in online learning is described as the capability of the student to develop social and emotional competences, and is related to characteristics, such as affective expression, open communication and group cohesion; (ii) *teaching presence*, which presents an important contribution with regard to the student's satisfaction, perceived learning, and the role of the community. As a matter of fact, in the learning context, the quality of discourse and the level of depth are influenced by the metacognitive thinking, being the teacher primarily responsible for these effects; and (iii) *cognitive presence*, characterized by four phases of the inquiry process, i.e.: *triggering event*, *exploration, integration* and *resolution*. Indeed, this community seems to focus on online learning, interaction among participants, as well as the development of collaborative work. The knowledge, in turn, is acquired from the interpersonal relationships in which students are not passive learners once they actively collaborate and learn as a group (Garrison et al. 2000). Subsequently, the structure of the *Community of Inquiry* (CoI) framework was redesigned by Redmond and Lock (2006), originating the phenomenon "Knowledge in action". However, Garrison and Arbaugh (2007), in the context of higher education, showed this type of community mainly as a tool, aiming to critically reflect upon the learning processes and focusing, particularly, on OLEs. So, from the increase of OLEs and the consequent technological development emerge the first distance education (DE) experiences related with the use of e-learning platforms (e.g., LMSs). In this line, Zhang and Wang (2005), add the following:

> In the early 1990s, having realized the great potential of online learning, some higher education organizations with advanced educational technology support started to develop online courses. (…) some educational and business organizations developed online teaching/learning tools (learning management systems), in order to meet the increasing need for education and lifelong learning (p. 245).

In higher education context, e-learning platforms are widely used as institutional promotion to attract target audiences, without a profound pedagogical change (Delta Consultores 2008), and at the same time regarded as one of the pillars of the promotion of student-centered education and lifelong learning (Bih 2007; Erazo 2006). However, some authors, such as Lewandowski (2003) and Bartolomé (2008), point out that fully DE (e-learning) did not reach all the expectations that had initially created, due to high costs and susceptibility of the environment to high dropout rates. As a result, inevitably, other modalities have emerged, characterized by a mix of distance and F2F learning environments. From this perspective, several studies have indicated the existence of a wide use of mixed solutions—*blended (b-) learning* (Aiello and Willem 2004; Gebera 2008; Lewandowski 2003; Marsh et al. 2003).

In general, the spectrum of different types of e-learning can be seen as a continuum from F2F (no e-learning) to fully e-learning (DE). With regard to the b-learning mode, three intermediate modes can be understood, namely: *Classroom*

aids, *Computer Labs* or *Hybrid*. In particular, in Classroom aids mode, the teacher uses ICT during the F2F lessons through the creation of a course website (supported by a LMS). Moreover, in Computer Labs mode, the course is mainly realized around PCs or laptop programs. On the other hand, the distributed (d-) learning mode can be hybrid or support courses fully in e-learning.

Inevitably, particular changes in online teaching and learning environments tend to occur; however, new educational environments require renewed attitudes and competencies of teachers and students, in order to avoid the traditional approach where the teacher is seen as the unique source of information/knowledge and students seen as passive receivers (Adell 1997). In turn, the effectiveness of education systems and distance learning, among other issues, is based on the ability to adapt the system to the different teaching and learning styles (Felder and Brent 2004). Also, online communities across a variety of platforms are considered privileged places of learning, which, due to their interactive and collaborative nature, enable the sharing information among several users, as well as the ability to motivate new people to use ICTs (Ala-Mutka et al. 2008). According to "engaged, empowered, enabled" logic, based on collaborative environments, Romeo (2006) notes that: "Anywhere/anytime learning will be characterized by student-centered, project-based learning with the role of the teacher and the learner redefined. The future will belong to the e-teacher and the e-learner" (p. 156). In this vein, the role of e-student and e-teacher is discussed in the following two subsections, respectively.

2.2.1 The Role of e-Student

According to Bruns and Humpherys (2007), the teaching-learning process has adopted new styles of work, promoting the concept of *produsage*, in order to emphasize certain skills and attitudes, namely:

- Creativity—students need to develop certain skills, in order to become co-creators, embedded in collaborative work environments, play flexible roles, and highlighting their self-efficiency for creative production;
- Collaboration—it is important to develop skills that will guide them to a shared (collaborative) participation/engagement;
- Critical capacity—students in co-creative contexts need to develop critical-thinking skills (Yeh 2012), in order to establish the most appropriate context for their involvement in the process of *produsage*. During the collaboration process, the critical meaning is indispensable, in order to give and receive constructive feedback;
- Communication—in a collaborative environment, there is a particular concern with regard to effective and assertive communication among students. In this sense, students need to be able to receive constructive criticism and available to communicate in creative processes with other individuals. These are aspects of communication that seem to need be worked specifically, rather than being

assumed, from the beginning, as inherent to the communication skills of the students.

In this scenario, Visser (2005) also proposes some practical suggestions to enhance the potential of online environments; more specifically:

> (a) Students can share and discuss the diversity in experiences and expectations present in the class; (b) Students can take an active role in providing evaluative feedback on the work of their peers; (c) Students can become sources of motivational support for one another; (d) Groups of students can build mutually beneficial collaborative relationships; (e) Students with greater experience in distance education can be encourage to serve as a resource for students who are at risk of dropping out or falling behind (p. 299).

Thus, the Information and Knowledge Society can be seen as a collectivity of multiple learning opportunities. Knowing that the students with negative attitudes in OLEs are less able to understand the contents of the courses, it is necessary to construct feelings of trust, more dynamic and interactive paths, shifting the role of mere passive receivers to proactive agents in the search, selection, processing and sharing information (Howland and Moore 2002). In this way, it seems reasonable that the platforms (e.g., LMSs) as well as pedagogical models should try to fit to the differences of the students. Also, for DE institutions in transition to the Web (1.0/2.0/3.0), there are opportunities and responsibilities to redefine/readjust the role of the teacher and the student (Visser 2005).

2.2.2 The Role of the e-Teacher

Berge (1995), identifies four key-areas of intervention, concerning the general role of e-teacher. More specifically, he refers to:

- Pedagogical area—i.e., the e-teacher is seen as a facilitator of the teaching-learning process, stimulating group work, discussions and questioning;
- Social area—i.e., the e-tutor promotes relations between all stakeholders of the group, establishing, *a posteriori*, a harmonious learning community, constituting a group identity in sharing information;
- Management area—i.e., the e-teacher needs to concern with issues related to the organization, planning and management of the course, establishing rules and objectives; and
- Technical area—i.e., the e-teacher implements efficient technologies, focusing the attention of the student to the contents (e-activities), rather than to the actual ICT that is used.

In this context, Stevens (2010) also underlines that:

> The relationship of e-teachers to traditional face to face teachers had to be considered, the creation of m-teachers and, subsequently, m-teams developed and administrative and technical support for virtual educational environment had to be provided (p. 235).

In the above line, in the United Kingdom, several Master's programs (in particular ICT modules) have been realized in a b-learning mode (integrating a hybrid model with a F2F component, online, and video conferencing), enhancing the role of the e-teacher (MTutor) as manager of the online learning environment. An example is given below (Wheeler 2005):

> MTutor was created by the University of Plymouth's Faculty of Technology, the department specializing in research into artificial intelligence. (…) The designers of MTutor have incorporated an intelligent tracking system into its functionality, which enables course tutors to monitor students ' progress through a series of online activities. The 'meeting minds' occurs when the students within the clusters begin to discuss their solutions online and develop a community of practice through collaborative learning (p. 151).

Furthermore, Visser (2005) identifies some strategies (in terms of design, development, and implementation) as a key to increase the effectiveness of teachers in the context of distance learning, tabulated in Table 2.1.

Table 2.1 Visser's (2005) strategies to increase efficiency in the context of distance learning

Strategies	Examples of teachers' possible activities
Design	Employ deliberate, systematic course design and evaluation;
	Design course calendar to chunk submission of assignments;
	Design activities that embed software learning so students can adjust to the LMS;
	Design group assignments or activities;
	Create external administrative and technical support.
Development	Refine and reuse instructional materials;
	Develop clear assignment and activity directions;
	Identify outside resources for student support;
	Develop self-assessments and peer assessments where possible;
	Use self-correcting quizzes;
	Create FAQs and tutorials.
Implementation	Send group emails;
	Define a clear process for handling student questions;
	Provide sample products for highly complex assignments;
	Provide general class feedback on assignments;
	Create support groups or dyads;
	Restrict mentor communication with individual students and small groups;
	Share moderating roles with students.

As it is deduced from Table 2.1, in the whole of negotiation process, the implementation of more flexible online learning models seems to promote the adoption of open approaches to various forms of DE and training considering the particular characteristics/needs of each context.

2.3 Epigrammatically

From the previous sections, it is clear that a variety of issues should be taken into account for the development of OLEs, related with the coresponsibility of the stakeholders on negotiation process within a b-learning environment. The rapid development and availability of the Internet produced a sea of change, fostering fundament alterations in the way ICTs can be utilized in the classroom. Access to the Internet outside of formal classroom settings has opened up possibilities that were inconceivable 10 years ago. Gradually, and according to the twenty-first generation description discussed in Sect. 1.1, for many students their home will be the principal place of access to the Internet and the word *classroom* will assume a whole new meaning.

The technologies, however, can easily become solutions looking for problems to solve, a trap that will be avoided by e-educators who have a vision for what they can achieve. It is naive to think that e-education can happen without the associated technologies, but it is perversity to think it will happen without teacher buy-in and participation in the vision-building that will be required. Solutions developed by instructional designers and multimedia specialists will not change the e-education world unless the teachers are the learning designers of the future. E-teachers will support and promote change when they feel they are an indispensable part of the process. In this endeavour, it is essential to embrace and integrate the appropriate techno-pedagogical strategies, as it is clearly explained in the chapter that follows.

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Chapter 3
Embracing and Embedding Techno-Pedagogical Strategies

3.1 Introduction

The importance of educational models that support learning in the digital age seems to be modestly explored in academic research communities. In 2004, Hewitt explores the concept of *knowledge building community* in his book *Designing for Virtual Communities in the Service of Learning*, and defines it as a type of CoP that integrates the following characteristics: (i) sharing of knowledge, values and beliefs; (ii) common points of coexistence among members; (iii) mutual interdependence; (iv) mechanisms for reproduction; (v) common practices; (vi) opportunities for interaction and participation; (vii) significant personal relationships; and (viii) respect for different perspectives and minorities (Hewitt 2004).

The WWW has strengthened the exchange of knowledge and the sharing information, as well as the communication and collaboration between users, which according to Lévy (2001) can be defined as a virtual world that promotes the collective intelligence. Nevertheless, in order to clarify the profound transformations in the last fifteen years in different contexts, Hayes (2006) categorizes the evolution of the Web into three fundamental moments: *Web 1.0* (Web one-way), *Web 2.0* (Web two-way), and *Web 3.0* (collaborative Web in real-time). Effectively, the Web 1.0 revealed major technological advances in terms of access to information and knowledge, based on a concept of global network, i.e., an open space to all. At the beginning of the twenty-first century, an increased use of tools was understood. For the O'Reilly (2006) the Web 2.0 is the shift to the Internet as platform, promoting the benefits of collective intelligence. Nowadays, when referring to the use of ICT, it is almost unavoidable to not refer to the term Web 2.0. In fact, the later is connected with the concept *Social* Web, which has been explored as a set of digital applications that allow interaction, collaboration and information sharing among users (Owen et al. 2006; Pascu 2008). According to the later cited works, these digital applications require the following features:

- student co-production of content;
- social networking;
- sharing of multimedia;

S. B. Dias et al., *Towards an Intelligent Learning Management System Under Blended Learning*, Intelligent Systems Reference Library 59, DOI: 10.1007/978-3-319-02078-5_3,

- a social system of categorization of files by tags (social tagging); as well as,
- social virtual games.

Furthermore, the growth of the online interaction as a strong social dimension (social computing), has shown distinct dynamics, in a social and economical level, that may promote a techno-economic paradigm (Pascu 2008). From this vision, social software is a key-element in learning, supported by different types of media, incorporating different ways of communication and collaboration, in order to reinforce the construction of knowledge, with regard to the specific needs of each context (Owen et al. 2006). Indeed, based on online environments and social networks development, sophisticated platforms that enable users to have access to a greater range of features (multi-functionalities) have increasingly appeared. For instance, the notorious "Second Life" (SL) consists of a three-dimensional virtual environment in which the created content is upon the responsibility of its users, allowed, for example, to simulate some issues of real-life and social aspects of the human being (Ondrejka 2004). Additionally, in "Virtual Worlds, Web 3.0 and Portable Profiles",[1] Hayes (2006) introduced virtual worlds as the 3-D Web (or Web 3.0), with a focus on real time collaboration and communication aspects within *Multi User Virtual Environments* (MUVEs). The latter can be recognized as virtual environments that allow several participants (avatars) to interact with digital artifacts, communicate with other avatars, as well as participate in experiments that simulate problems very similar to real contexts, as emphasized by Dede et al. (2004):

> Multi-user virtual environments enable multiple simultaneous participants to access virtual contexts, to interact with digital artifacts, to represent themselves through 'avatars', to communicate with other participants and with computer-based agents, and to enact collaborative learning activities of various types (p. 158).

Deeping more to the SL case, its users can construct and recreate spaces/buildings/virtual stores, exposing major events, business or even university courses (OECD 2007). In this context, academic institutions have endorsed SL to explore its educational and institutional potential, as well as to promote a wider public participation in the events. *Grosso modo*, the SL universe represents more than five million people around the world, encompassing in its space 70 universities and foreign educational organizations.[2] For example, the Universitat Oberta de Catalunya (UOC, Spain),[3] is a well-known distance HEI that created a *Virtual Campus* (an integrated e-learning environment), in which any person has access to specific programs, as well as to academic and non-academic services, allowing users to communicate with other users using an e-mail system, virtual classrooms, a digital library and other e-learning related tools. This kind of network tends to allow an easy interoperability between systems and among teachers and students,

[1] From http://www.personalizemedia.com/virtual-worlds-web-30-and-portable-profiles

[2] From http://www.cienciahoje.pt/index.php?oid=21245&op=all

[3] From http://www.uoc.edu

in a synchronous and/or asynchronous, as well as to give access to other institutions/centers/services, in general.

Interestingly, with the main purpose to integrate the experiences of SL with the potential of the learning environment provided by the open source Moodle platform (www.moodle.org, see also Sect. 3.2.8), a combinatory project was developed, namely Sloodle (http://www.sloodle.org), representing the blending of the two concepts, i.e., SL and Moodle. Sloodle, also known as Virtual Learning Environment (VLE), aims at connecting the learning system to the management tools of LMS in a multiuser 3-D virtual world. In this vein, an available course in Moodle platform can easily be integrated into a 3-D interactive classroom (using all features available in a combination of Moodle and 3-D virtual environment). Practically, an object in the virtual world can formulate questions to an avatar that is navigating in a particular place, and the answers can be sent directly to the LMS Moodle.

Accordingly, several studies have already revealed the actual implementation and use of different 3-D immersive environments in e-learning and b-learning contexts (Hedberg 2006; Hetherington et al. 2008; Edirisingha et al. 2009; Kemp et al. 2009; Omale et al. 2009; Sancho et al. 2009; Burgess et al. 2010; Swan and Ice 2010). In general, considering the particular characteristics/needs of the users and the different forms of MUVEs and LMSs uses, these studies have reported that motivation, social presence, sharing of knowledge, communication and interaction of users were considered the major priorities, in order to efficiently integrate these environments in the educational context.

3.2 Techno-Pedagogical Analysis of Web 2.0 Tools

In the context of teaching–learning process, the Web 2.0 has been supported by various communication tools and instructional technologies. Some examples and their educational potentialities are described next.

3.2.1 Social Networking Services (SNS)

Social Networking Services (SNS) are communication tools that have a strong social component that extends the online interaction of students (Cachia 2008). The role of SNS can be better understood from the perspective of social spaces, i.e.: “Internet or mobile-device-based social spaces designed to facilitate communication, collaboration and content sharing across networks of contacts” (Childnet International 2008, p. 5). Young people, for instance, tend to use the SNS in various contexts, with the main objectives being to: keep in touch with friends; develop new contacts; share content and enhance its expressiveness; explore their identity; consume commercial content; have access to information and informal learning (Davies and Cranston 2008). Characteristic examples of

SNS include well-known online social networks, such as Facebook, Myspace (social purpose-oriented (Childnet International 2008)), LinkedIn (professional contacts-oriented (Cachia 2008)), SL (world/virtual game-oriented (OECD 2007)), or the Elgg (learning and knowledge development-oriented (Childnet International 2008)).

SNS, from a pedagogical perspective, potentiate users to (Childnet International 2008):

- develop e-portfolios as an online space where students can review their documents, explore and enhance their talents/interests;
- facilitate reading and communication
- promote collaboration and group work;
- support learning through copyright protection;
- discover their representation in the digital world;
- develop their learning around online security issues (e-safety); and
- develop communities, depending on their interests.

3.2.2 Blogs

Blogs can be defined as a type of a Web page (Weblog), with regular updates, with text, image, audio, video or a combination of them (OECD 2007). A blog is a system that belongs to an author (or group of authors), who writes/publishes articles with a set timestamp, namely posts (Franklin and Van Harmelen 2007). Owen et al. (2006) stated that young people increasingly have become authors of blogs, originating the phenomenon of *blogosphere*. Williams and Jacobs (2004) go further and add that "blogging has the potential to be a transformational technology for teaching and learning" (p. 232).

The pedagogical potentialities of blogs are reflected within the following observations (Bartolomé 2008):

- teachers use blogs as a facilitator to create dynamic learning environments, without prior knowledge or skill in HTML format;
- students use blogs as an alternative to digital profiles; and
- blogs have been used predominantly to support collaborative work.

Franklin and van Harmelen (2007) report the following:

> A group of bloggers using their individual blogs can build up a corpus of interrelated knowledge via posts and comments. This might be a group of learners in the class, encouraged and facilitated by the teacher, or a group of relatively dedicated life-long learners (p. 5).

In fact, there are also sites of blogs, such as Edublogs (e.g., Blogger, Wordpress), which offer free blogs, specifically for students and teachers (Rudd et al. 2006a).

3.2.3 Wikis

Wikis can be understood as a system represented by one or more persons towards building a body of knowledge of a set of interconnected webpages, using a process of creating and editing pages. In addition, opposite to the blogs, the wikis includes the rollback functionality (Anderson 2007). Also, wikis include an online collaborative environment in which the user and team members can enter in order to include text, images, videos, links to audio and video files and even formatting content of various forms (Warlick 2006). The Wikipedia applies the wiki technology, and provides a fast and flexible way for anyone to create/edit and link pages together (Anderson 2007; Franklin and Van Harmelen 2007; OECD 2007; Owen et al. 2006).

From a pedagogical perspective, wikis (Bartolomé 2008; Bryant 2006; Franklin and Van Harmelen 2007; Warlick 2006):

- allow users to enhance the collaborative writing or to develop projects that involve multimedia, particularly used in the creation of guides of collaborative studies, texts, books and themes of the particular area of knowledge;
- can be simply used as an alternative to a class that uses Websites, enabling the contribution and registration of ideas and comments to a wider group of people; and
- can also be seen as a tool for a teacher to develop collaborative and enriched learning environments.

3.2.4 Social Bookmarking

Social Bookmarking allows users to record Web pages (bookmark) and label them with the most relevant words (tags) that describe which pages were initially recorded (Franklin and Van Harmelen 2007). The process of organization of information through labeling, it is also known as *folksonomy* (Alexander 2006; Owen et al. 2006) or *social tagging* (Vuorikari 2007). In particular, Vuorikari (2007) recognizes the following advantages: "Social tagging potentially offers advantages in terms of: personal knowledge serendipitous access to resources management; and enhanced possibilities to share content with emerging social networks" (p. 7). The concept of social tagging has been extended and integrated various applications of online interaction with a strong social dimension, allowing a variety of digital products and services, such as Flickr (photos), YouTube (videos), Odeo (podcasts), resulting in a diverse social labeling (Anderson 2007). Particularly, Delicious, Furl and Bibsonomy are some typical examples of social bookmarking tools.

The pedagogical potentialities of social bookmarking are recognized through the following implications:

- teachers/students, through bookmarking, can construct a set of resources, with the purpose of sharing information and collaboration in digital content selection with others (Alexander 2006; Franklin and Van Harmelen 2007; Vuorikari 2007);
- with the use of multiple markers (tags) it is possible to build reading lists (Franklin and Van Harmelen 2007);
- groups of users with common interests can form a team, in order to monetize bookmarking service, enabling sharing of bookmark items of common interest (Franklin and Van Harmelen 2007);
- teachers/students can recommend and comment specific resources that are available; and
- bookmarks can also be placed in an individual blog or in a common Website, in promoting cooperation with each other and, simultaneously, monetizing efforts (Vuorikari 2007).

3.2.5 Media-Sharing Services

Media-sharing services (or media-sharing spaces) enable users to post/share photos, posdcats and videos and, at the same time, support great potential for educational purposes.

YouTube (movies), iTunes (podcasts and vidcasts), Flickr (photographs), Slideshare (presentations), DeviantArt (artwork) and Scribd (documents), are typical examples of this type of services (Franklin and Van Harmelen 2007). In this way, Web-accessible videos for educational purposes can easily be produced; a characteristic example is the YouTube, where numerous educational videos are freely available (Downes 2008). Moreover, the podcasting and vodcasting are communication tools that offer great potential (Cruz and Carvalho 2007), since podcasting can be seen as a way for a student to quickly update a recent video or song, whereas vodcast acts as means for constructing a video version of a podcast (Franklin and Van Harmelen 2007). Accordingly, these tools are considered very exciting for students, since they take into account their own individual pace of learning and, simultaneously, allow them to experience audio or video content several times (Morales and Moses 2006).

The pedagogical potentialities of the media-sharing services lie on the fact that they (Franklin and Van Harmelen 2007):

- can be used as prior material before readings, or to remember some readings, or even to repeat specific content;
- can be used in the distribution of media-sharing services and educational resources; and
- enable the availability of comments and critics about the work of others.

3.2.6 Online Applications

Online applications (Web office, Web desktop or WebTop) are software packages that represent desktop applications, such as Microsoft Office or Open Office, which usually include, e.g., a Word processor, spreadsheet, multimedia presentations (Bartolomé 2008). For example, Vicky Davis[4] shows in her blog entitled *The Cool Cat Teacher* a collaborative project, involving more than 40 teachers, using Google Docs as a presentation tool.

The pedagogical potentialities of online applications are realized via:

- collaborative presentation (e.g., by using the free available Google Docs), where students, although being at home, they can work collaboratively in presentations at school or create slide shows in a collaborative way with strong interactions, supported by chats;
- updating information, so teachers can perceive when students make revisions or access/work individually;
- real time planning and access of online activities (e.g., by using the Google Calendar or via chats);
- accessing to a vast number of learners from all over the world; and
- transferring the richness of a presentation to an audience through sharing of resources and comments.[5]

3.2.7 Concept Maps (C-Maps)

Concept maps (C-Maps) represent an eclectic range of flexible tools in e/b-learning environments. In C-Maps, in general, concepts are arranged hierarchically, i.e., more general concepts are placed higher on the map and specific concepts are located lower (Novak and Gowin 1996). C-maps are largely used in online environments that are able to be presented as learning tools in all stages of the learning process. The use of C-Maps as a way of promoting discussion and negotiation processes through communication tools can be really seen as a valuable learning tool. C-Maps have been widely used and tested as pedagogical tools (Hauser et al. 2006), as an important assessment tool (McClure et al. 1999), as a means to improve text comprehension and summarization (Chang et al. 2002), and, also, as a facilitator in supporting students' reflection (i.e., as mirrors or assistants to the learner) (McAleese 1998).

The pedagogical potentialities of C-Maps refer to:

- their contribution to the construction of unlimited concepts and relationships;
- their user-friendliness, as they are realized through easy tools with drag and drop interfaces;

[4] From http://coolcatteacher.blogspot.com/2007/09/and-walls-came-down.html

[5] See for example http://edtechlife.com/?p=1863

- their role as virtual guides inside a course, or as a facilitator of the relationship between the learner, the course structure and didactic contents and, simultaneously, as an organizer of different course resources;
- their clear orientation, as a learning activity, to the promotion of student's meaningful/active learning;
- their power as a tool for the presentation of complex knowledge networks;
- their usefulness as an evaluation tool that allows the exploration of the student's learning process; and
- their mediation as a tool of production of shared knowledge, facilitating collaborative processes of reflection and discussion.

3.2.8 Learning Management Systems

LMSs are seen as information systems focused on the processes of communication, collaboration and with well-defined educational purposes. For example, the LMS Moodle (corresponding to Modular Object-Oriented Dynamic Learning Environment), a free and open source platform based on socioconstructivist perspectives (Dougiamas 2007) developed by Dougiamas in 1999, allows users to incorporate various resources and functionalities in a modular structure (Williams 2005; Cole and Foster 2007; Ifenthaler and Pirnay-Dummer 2011). Additionally, seen as a Course Management System (CMS), Moodle can be used to manage the students' path, to monitor their performance, to create and distribute content, to organize e-activities, to evaluate, as well as to provide tools for communication, collaboration and interaction between the peers involved in the educational process. However, it is important to underline that incorporation of a wide range of activities in the LMS *per se* does not seem sufficient to enhance the teaching-learning process. According to Keegan et al. (2002) these kind of learning platforms (e.g., Blackboard, Formare, Moodle, Teleformar, WebCT) should be seen as an opportunity for institutions to develop learning materials, online courses, tests and evaluations, databases and to online monitor students' progress. In their book *Trends and Issues in Distance Education*, Zhang and Wang (2005) note that:

> These systems were designed to enable instructors to customize their own online courses effectively, without the need for advanced Web programming skills. These tools significantly reduced the time required to develop and manage online courses, which made it possible for large-scale development and cost-effective online learning (pp. 245–246).

In 2011, Portugal (in comparison with the other countries of the world) has occupied the first rank position in terms of LMS Moodle use, with already 846 registered sites in Portuguese servers around several cities of the country.[6] Nevertheless, the specific software used for the development of these online communities focused on teaching-learning process has raised some discussions concerning what pedagogical/instructional approach/methodologies should be

[6] Refer to http://www.google.com/trends/

adopted. For instance, the Web 2.0 tools can be readjusted according to the hermeneutic perspective (more objectivist or more constructivist), the context (more formal or more informal), taking into account the beliefs, values, motivations and social representations. As Bates and Sangrà (2011) suggest: "Teachers must decide which tools are most likely to suit the particular teaching approach" (pp. 44–46).

From a pedagogical potentiality perspective:

- LMS can be seen as a flexible educational approach that includes several Web 2.0 tools and enables the reorganization of these tools differently, depending on the personal interpretation of the teacher (Bates and Sangrà 2011);
- by using the LMS, teachers will be able to experience modeling of elements of course design directly in the LMS itself, share in an safe environment with a known audience and see examples of pedagogy from the showcase area, all of which are characteristics of effective professional development for teachers (Harlen and Doubler 2007).
- by including and encouraging examples of teachers' LMS practice will demystify the unknown of what colleagues are doing, seen as a significant barrier to educators integrating b-learning approaches into their teaching practice (Diaz and Brown 2010); and
- by using LMS within the b-learning context, "emulation of the student experience" along with provision of a home for a learning community could be achieved (Diaz and Brown 2010).

3.3 Potentialities and Constraints of Web 2.0

3.3.1 Potentialities

There are many reasons to explore the factors associated with the Web 2.0 in the learning context. From educational and social research point of view, new approaches of the learning process have been increasingly discussed, recognizing its forms of connectivity and collaboration (Rudd et al. 2006b). Moreover, the organization of work (teachers' and students') through phenomena like social networking, collaboration and connectivity, implies the establishment of complex roles in the learning process and knowledge construction, as the four proposed by Rudd et al. (2006b):

> (1) higher order functions arise through social interactions; (2) knowledge is socially constructed between learners and experts, not simply 'acquired' or 'delivered'; (3) learning is understood to be more powerful when pro-actively scaffolded by expert others; (4) progress is greater when learning focuses upon collaborative rather than independent problem solving (p. 4).

Coenen (2006), in his study of the relationship of networking systems and their influence on knowledge-sharing concludes that the social software influences the creativity through shared knowledge amongst individuals. Consequently, the need to readjust the rules of teachers and students appears, positioning students at the center of the teaching-learning process. In this scenario, the natural trend for the use of technological resources (e.g., Elgg) seems to represent great potential, where the control of various aspects related to the learning process, which were previously controlled by the teachers, can be transferred to the students (Rudd et al. 2006a). Thus, mainly issues related to the social software, including the communication, collaboration and community building, appear as key-components to help and to develop the culture of the *learner voice* (Rudd et al. 2006a). This kind of culture assumes a more personalized education nature, advocating greater possibilities to sharing information with others, in general. Furthermore, Green et al. (2005) corroborate the emphasis to personalization in education environments and suggest, among other aspects, an educational system that integrates the needs, interests and potential of all students. In addition, nowadays, most students tend to be prepared to create and customize learning environments (digital resources) outside-school (Green et al. 2005). Alexander (2006) also suggests some advantages for using Web 2.0 communication tools:

> Web 2.0's lowered barrier to entry may influence the variety of cultural forms with powerful implications for education, from storytelling to classroom teaching to individual learning. It is much simpler to set up a del.icio.us tag is the topic one wants to pursue or to spin off the blog or blog departmental topic than it is to physically meet co-learners and experts in the classroom or even to track down the teacher. Starting a wiki-text entry level is far easier than beginning an article or book (p. 42).

In this sense, in the context of higher education, a significant interest about Web 2.0 applications that efficiently support teaching and learning have appeared. The words of Franklin and van Harmelen (2007) support this idea as follows:

> A major aim in universities is to produce independent (or autonomous) learners. The working definition is: Independent learners are self-directed learners who are able to set their own learning goals; develop strategies and plan how to achieve those goals; work towards realizing the goals, either on their own or with others; and reflect on their learning processes and outcomes, in turn learning by that process of reflection (p. 21).

In addition, the use of communication tools, such as video conferencing, e-mail or even online communities, appear to be advantageous for the teaching-learning process (if F2F contact is not possible or necessary), offering opportunities for promoting collaboration and distance education programs (Green et al. 2005).

Besides, several studies have revealed that access to digital technologies contribute to the development of students' informal learning, via the acquisition of the proper information, communication with others that also support their learning, and knowledge/experiences-sharing through informal learning communities (Sutherland et al. 2000; Cook and Smith 2004; Sefton-Green and WAC Performing Arts and Media College 2004; Sutherland et al. 2004; Attwell 2007).

3.3.2 Constraints

Although some studies have evidenced potential contributions regarding the applications of Web 2.0 tools, others point out that, concerning effective learning, it is not so straightforward to demonstrate significant changes/adaptations (OECD 2008). For instance, the coexistence of digital technologies in school and at home has clearly produced notorious repercussions in the education system (Green et al. 2005; Davies and Cranston 2008). On the other hand, other studies show that accessibility is still one of the main obstacles to provide equal opportunities, assuming an enormous constrain in terms of social and digital inclusion (Akbulut and Kiyici 2007; Davies and Cranston 2008). For example, the use of computers in European schools has reached almost the 100 % saturation point in all member states; however, a remarkable variation in the number of computers per 100 pupils was observed.[7] Moreover, the same report *Benchmarking Access and Use of ICT in European Schools* also revealed that Portugal and Greece have only 6 computers per 100 pupils (Korte and Hüsing 2006).

Another serious constraint is related to security and bullying issues. In a survey concerning profiles of United States, teenagers were found that about 82 % of profile creators include their first name in their profiles, 49 % include the name of their school, 29 % include surnames, and 2 % include the mobile phone numbers; also 5 % have publicly visible profiles showing their full names, photos and information of where they lived (Lenhart and Madden 2007). However, several researchers have expressed some concern regarding sharing of personal data, since these may be used to promote *bullying* phenomenon, or used to promote *online grooming* (Davies and Cranston 2008; Ortega et al. 2009; Erdur-Baker 2010).

In addition, ICTs, in particular the mobile phones and Internet, have also been widely used to encourage a social and psychological phenomenon, commonly called *cyberbullying* (Childnet International 2008). Fortunately, in some institutions, where particular cases of cyberbullying amongst students and faculty occurred, have adopted drastic countermeasures for limiting access to certain sites of collaborative content (Ala-Mutka et al. 2008).

Furthermore, other phenomena, such as *advertising* and *spamming*, can also reflect a threat in the use of Web 2.0, especially for younger users (Davies and Cranston 2008). These, clearly indicate the need for developing more robust methods considering the prevention of these phenomena and their avalanching (Hayati and Potdar 2009). Additionally, with the Web 2.0, multiple individuals can create/modify online content, leading often to uncertainty about who really are the content producers, involving *copyright* issues (Franklin and Van Harmelen 2007), and serious violations (conscious or not) of both copyright and moral rights (Ala-Mutka et al. 2008).

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[7] More specifically, the following European leaders were identified: Denmark (27 computers per 100 pupils), Norway (24/100), United States (20/19) and Luxembourg (20/18) (Korte and Hüsing 2006).

3.4 Towards Blended Understanding in a Web 2.0 World

Internet, according to Franklin and Van Harmelen (2007), covers a vast amount of material in the public domain that can be accessed and used freely. In turn, the resources needed to create learning activities based on the use of Web 2.0 tools, in particular in the context of education, are mostly freely available and accessible, i.e., the so-called Free/Libre and Open Source Software (FLOSS). From this vision, Bates and Sangrà (2011) note that:

> Some will argue that open source allows more flexibility, but others will argue that commercial systems are more stable. In practice, good course design (clear objectives, well-structured learning materials, good graphics) is likely to be more influential on learning outcomes than the choice of an LMS (p. 107).

Indeed, the emergence of new models of learning seems to be associated with the implementation of new strategies of innovative Web 2.0 learning. In the United States, for instance, several trends have been identified, reflecting a *progressive* or *conservative* impact on DE practices (Wilson 2005). On one hand, progressive practices (associated with more innovative teachers) tend to stimulate different ways of thinking, based on new challenges/changes, as well as the use of new educational tools/strategies. On the other hand, conservative practices are concerned with gains of productivity, efficiency, quality control and responsibility already obtained (associated with more traditional teachers). Nevertheless, both of these influences should be considered in a culture of change, in order to create and/or reconsider new distance learning programs (Wilson 2005). Marchessou (2005) also exposes the following thought:

> The emphasis is no longer on technology but on the complex human factors involved, as it should have been from the start. It is to be hoped that the years to come will surprise us with a wealth of inventive projects that may help bridge those digital divides (p. 65).

From a global perspective, assuming that knowledge is one of the key factors of competitiveness in the Information Society, it is reasonable to say that knowledge networks, learning communities, online collaborative environments, and e-learning systems have played an important role in the daily life of each individual/community, with particular emphasis on the educational institutions. Besides, from an international perspective, some universities have discussed and showed as a more effective educational guidance the creation/development of online platforms based on educational models that respect the particular characteristics of the context (Visser et al. 2005). In general, constructivist principles recognize that real-life learning is chaotic and complex. According to ecological model of Siemens (2006), connectivism is based on integration of principles explored by network, chaos, complexity and self-organized theories. So, to gain a better understanding of the process of learning as a dynamic process of co-creation and co-production, classrooms which follow the "fuzziness" are better *equipped* to preparing learners for LLL.

According to the aforementioned, the course towards blended understanding of Web 2.0 is almost imperative. Thus, in an effort to show the unit of the present book and to better understand the connection of the theoretical frameworks (refer also to Sect. 1.2) with their practical approaches described in Part III (Chaps. 7–11), a graphical representation it is structured, depicted in Fig. 3.1. In the latter, OLE#1 (Sect. 1.2.1) refers to the five-step model of Salmon (2000); OLE#2 (Sect. 1.2.2) corresponds to the model of e-learning based on the types of interaction (Anderson 2004); OLE#3 (Sect. 1.2.3) is drawn from the ecological model of learning (Siemens 2006); OLE#4 (Sect. 1.2.4) refers to the TPACK model (Mishra and Koehler 2006); OLE#5 (Sect. 1.2.5) is drawn from the integration of Social Media in classroom (Bosman and Zagencyk 2011); OLE#6 (Sect. 1.2.6) corresponds to the TOPs model (Sangrà 2008); whereas OLE#7 (Sect. 1.2.7) refers to *i*LANDS of Learning 2.0 (Redecker et al. 2009).

In fact, Fig. 3.1 implies the blending of the theoretical assumptions, such as "Networking", "Embracing Diversity", and "Opening up to Society" drawn from the *i*LANDS structure (Redecker et al. 2009), with new channels of information

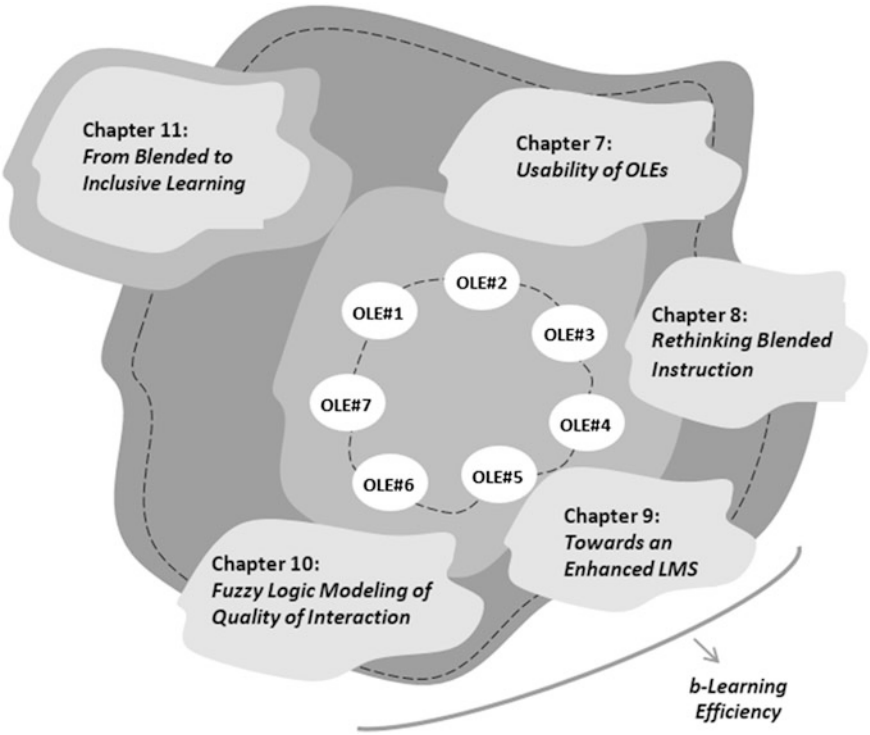

Fig. 3.1 Graphical representation of the core theoretical frameworks (OLE#1–OLE#7) related with practical approaches described in Part III (Chaps. 7–11). The *dashed outlines* indicate the interconnection of models (*inner*) and chapters (*outer*) considered towards an intelligent LMS under b-learning modality

and more intelligent ICT-based mediators that relate with the development of skills and social construction of knowledge, in a more collaborative and inclusive online community. Practical approaches based on these theoretical frameworks through case studies and formation of empirical models and profiles that enhance the intelligence of the LMS interfacing, seen also from the inclusive perspective, are presented in Part III (Chaps. 7–11). Nevertheless, before embarking towards such endeavor, the succeeding part (Part II, Chaps. 4–6) sheds light upon the data acquisition, handling and analysis approaches, to facilitate the understanding (from a general perspective) of the methodologies applied to the case studies of Part III.

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Part II
Blending Quantitative and Qualitative Methods: Triangulation as a State of Mind

Chapter 4
Data Collection Strategies

4.1 Introduction

In general, this part describes ways of data collection and analysis, pointing out the central technical and methodological procedures considered. To this end, and in order to describe, characterize and understand the online learning community of a public HEI in b-learning mode, the case study was considered the most appropriate methodological approach. According to Yin (2006), the case study is an empirical research process that intends to study a contemporary phenomenon in the real context, being particularly suited to adopt when the boundaries between phenomenon and context are not clearly transparent. In Yin's own words (2006): "Compared to other methods, the strength of the case study method is its ability to examine, in-depth, the 'case' within its 'real life' context" (p. 111). Generally speaking, the case study aims to tell a story that adds something to the prior knowledge and is, as far as possible, interesting and illuminative (Yin 2006).

Furthermore, among the different types of empirical research, the one that best fits the objectives of the present book is the applied research, since it allows the use of the theoretical assumptions that underlie the development of OLEs, in order to solve a practical problem. In this case, the aim is to improve the educational practice supported by ICTs, under b-learning mode, in the context of higher education. In turn, the option to use both quantitative and qualitative methods may be extremely advantageous during an investigation, because it provides the researcher with more opportunities to capture multiple dimensions of the same reality. In other words, as Kumar (2005) notes:

> Quantitative and qualitative research methodologies differ in the philosophy that underpins their mode of inquiry as well as, to some extent, in methods, models and procedures used. Though the research process is broadly the same in both quantitative and qualitative research is differentiated in terms of the methods of data collection, the procedures adopted for data processing and analysis, and the style of communication of the findings (p. 17).

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Research adopting the quantitative approach (positivism paradigm) is said to be mostly numerical and is designed to ensure objectivity, generalizability and reliability (Smith et al. 1991). One important feature of quantitative techniques is that the process of data collection is distinct from analysis. Some techniques, such as interviews or observations, nevertheless, can be interpreted either quantitatively or qualitatively. In the latter case (phenomenological paradigm), qualitative approach deals with the way people experience phenomena in the world and define its meaning. In particular, Van Maanen (1983) defines qualitative methods as an array of interpretive techniques which seek to describe, decode, translate and otherwise come to terms with the meaning, not the frequency, of certain more or less naturally occurring phenomena in the social world. They are less structured, longer and have a more flexible relationship with the respondents so the resulting data have more depth and greater richness of context (Aaker et al. 2001). It also means that the potential for new insights and perspectives is greater. Nevertheless, the data compiled by this approach may also look very 'untidy' because of the researcher's lack of control on them. For instance, it is impossible for a researcher to maintain the same discussion when interviewing various individuals. This is due to the fact that humans are often encouraged to talk about unrelated things from time to time. As a result, the analysis and interpretation of the data may be very difficult. Hence, when simultaneously dealing with the problem of generalizing and understanding ideas, it is better of incorporating both approaches whenever possible (mixed case). The understanding of both paradigms helps identify the ways these divergent approaches complement each other. For example, collection and analysis of documents, as well as more quantitative methodologies (including survey methodology) sometimes proves to be insufficient; hence, qualitative methodologies could also be considered. In this line, Denscombe (2007) adds:

> The most obvious extra demand on the research comes in the form of the multi-skilling that is required. If the research is to use more than one method in order to triangulate, he/she must become proficient in the use of the alternative methods-and this takes time (p. 138).

In their book *Qualitative-Quantitative Research Methodology*, Newman and Benz (1998) have an interesting conceptual representation, i.e., "Qualitative-quantitative interactive continuum", which is based on the assumption that the qualitative methodologies have a more quantitative perspective and vice versa, varying according to the depth of investigation of a particular field and of the new categories of interest emerged by the analysis of the results obtained during the investigation. In this sense, different ways to combine methodologies have been discussed, using concepts, such as triangulation, mixed methods/models or multiple methods. However, the concept of *triangulation* seems to be the most widely used in the literature, being perceived as fundamental towards an effective integration of methodologies (Denzin and Lincoln 2003). Denscombe (2007) evokes that:

> Triangulation cannot prove that the research has 'got it right'. In view of the nature of social reality and the nature of social measurement devices, triangulation's potential needs to be seen more cautiously the 'providing more support', 'increasing confidence' and 'reducing the possibility of error' (p. 138).

In a practical way, the triangulation concept can be realized by using:

- different types of participants, i.e., teachers and students;
- different instruments, i.e., questionnaires, interviews and documental analysis; and
- various data approaches.

The sections that follow describe the documental collection with the phases of preparation and implementation of data collection techniques, as well as some procedures/instruments that can be adopted for the handling and analysis of the collected data. All these, are in direct link with the case studies that are presented in Part III, as they serve as their methodological bases.

4.2 Documental Analysis

In addition to examining written documents, the documental analysis technique (Gray 2004) can also be applied to images (pictures), audio (music) and audio-visual documents (videos). Actually, with ICTs, some new ways and more ubiquitous forms of digital information and content has been the object of analysis of some investigators. For example, digital information available on Websites, blogs, wikis, online communities, among others, are valuable source of data collection for research (Gray 2004).

One way to initiate documental analysis is to have a first look at the use of ODLs in higher education worldwide, so to create a training context, i.e., a general analysis of institutional Web sites (see Appendix A). Furthermore, to characterize the context under consideration, the collection and analysis of information electronically available from the LMS Moodle of an HEI can follow. To this end, some statistical analysis reports (automatically created from LMS Moodle), regarding the "activity type", "access", "contributions", and "views" of all users of the LMS Moodle during an examined period of time can be extracted. Then, qualitative indicators concerning, e.g., the type of Activities, Structure and the Contents of all available disciplines in the LMS can be defined (see Chap. 7). At the same time, through the *Google Analytics* tool (http://www.google.com/analytics/), some metrics and a global view of the traffic in order to characterize LMS visitors at the same time period can be taken under consideration.

The whole information of the aforementioned documental analysis process serves as a basis to capture the context of the data and to get more acquainted with their true nature.

4.3 Online Survey

Survey is a common data collection technique involving questions. According to Forza (2002), a survey methodology aims to explain or predict the occurrence of a phenomenon, to test a theory or advance in the knowledge of a particular field. Additionally, Wright (2005) highlights some advantages and disadvantages in the use of survey methodology, namely:

> Advantages include access to individuals in distant locations, the ability to reach difficult to contact participants, and the convenience of having automated data collection, which reduces researcher time and effort. Disadvantages of online survey research include uncertainty over the validity of the data and sampling issues, and concerns surrounding the design, implementation, and evaluation of an online survey (p. 1).

In turn, Denscombe (2007) emphasizes that the surveys via Internet may be seen as a more economical and fast alternative of data collection (compared, for example, with the postal or telephone survey), reinforcing that this type of survey can be conducted in three different ways, in particular:

> (1) an email questionnaire: the questions are sent as part of the email itself; (2) the questionnaire sent with an email as an attachment; 3) the web-based questionnaire-the questionnaire can be designed as a webpage and located on the host site, waiting for people who visit the site to complete it (p. 9).

Sometimes, survey respondents (e.g., students) can exhibit heterogeneous characteristics; hence, some criteria should be defined that would, in some ways, reflect a homogeneous group of respondents. For example, the students participating in a survey could attend the same undergraduate degree and/or be enrolled at the same academic year.

As a safety net, a survey, before reaching the respondents, has to be previously reviewed by experts in the field, so a clear structure could defined, reducing, thus, the ambiguity of the questions. Furthermore, a survey has to be structured in such a way so to be easily understood by the respondents, eliminating any possible difficulties in the interpretation of its issues. An example of the use of an online survey targeting the students' community is presented in Chap. 7 (Part III), whereas the 11 main questions involved are provided in Appendix B.

4.4 Interview

The interview it is a data collection technique used in the studies of qualitative nature. Kumar (2005), points out the following advantages in the use of the interview (p. 131):

- the interview is more appropriate for complex situations;
- it is useful for collecting in-depth information;
- information can be supplemented;

- questions can be explained;
- interviewing has a wider application.

However, it is important to highlight that the length of such technical implementation and further analysis of contents may imply an application to a very limited number of individuals. Additionally, some constraints can be considered, for example, the interview is time-consuming and the quality of the data depends on the quality of the interaction established (Kumar 2005). When the interview is seen as a way of collecting data, its structural form should be taken into account, i.e., if it will be unstructured, structured or semi-structured (Hancock 1998).

The unstructured informal interview is normally conducted as a preliminary step in the research process to generate ideas/hypotheses about the subject being investigated, so that these might be tested later in the survey proper. Such interviews are entirely informal and are not controlled by a specific set of detailed questions. Rather the interviewer is guided by a pre-defined list of issues. These interviews amount to an informal conversation about the subject. Informal interviewing is not concerned with discovering "how many" respondents think in a particular way on an issue (this is what the final survey itself will discover). The aim is to find out how people think and how they react to issues, so that the ultimate survey questionnaire can be framed along the lines of thought that will be most natural to respondents. The respondent is encouraged to talk freely about the subject, but is kept to the point on issues of interest to the researcher. The respondent is encouraged to reveal everything that he/she feels and thinks about these points. The interviewer must note (or tape-record) all remarks that may be relevant and pursue them until s/he is satisfied that there is no more to be gained by further probing. Properly conducted, informal interviews can give the researcher an accurate feel for the subject to be surveyed.

With structured standardized interviews, the format is entirely different. A structured interview follows a specific questionnaire and this research instrument is usually used as the basis for most quantitative surveys. A standardized structured questionnaire is administered where specific questions are asked in a set order and in a set manner to ensure no variation between interviews. Respondents' answers are recorded on a questionnaire form (usually with pre-specified response formats) during the interview process, and the completed questionnaires are most often analyzed quantitatively. The structured interview usually denies the interviewer the opportunity to either add or remove questions, change their sequence or alter the wording of questions.

The semi-structured interviews are considered, by several authors, the most valued instruments in qualitative methodologies, for better understanding respondents' perspectives, as well as to interpret the complexity of their lives and organizations (Flick 2002; Denzin and Lincoln 2005). Additionally, further discussion of several topics with more depth and flexibility in the most important dimensions under study can be made using this technique. Brenner (2006) still emphasizes the following: "A semi-structured protocol has the advantage of asking all informants the same core questions with the freedom to ask follow-up questions that build on

the responses received" (p. 362). In the semi-structured interview, opportunities for both the interviewer and the interviewee to discuss some aspects in more detail are provided. Moreover, the semi-structured interview does not limit the interviewer to the questions previously prepared (giving some flexibility and fluidity in the global intervention), and ensures a conductive line that facilitates the subsequent content analysis of the data collected. Application of individual semi-structured interviews can be found in the case studies of Chaps. 7–9, with the relevant interview structural organization included in the Appendices C–E, respectively.

Sometimes, *interpersonal process recall* can also complementary be used during the development of the interview, as a means of interviewee's engagement reinforcement through self-reflection (Larsen et al. 2008). For example, in the case studies of Chaps. 8 and 9, a preliminary collection of information electronically available for each respondent in the LMS Moodle was performed, e.g., views, contributions, type of tools used. So, as a first step, the respondent observed some data concerning his/her activity in LMS Moodle. The second phase aimed at stimulating the interviewee's reflection with questions that would facilitate the connection with his/her practices, perspectives and beliefs with regard to the OLE. Finally, in the last phase, the user of the LMS Moodle extended the discussion upon some issues (if necessary) that needed further clarification.

4.5 Data Mining: Fuzzy Logic

According to Fayyad et al. (1996), Knowledge Discovery in Databases (KDD) can be defined as a broad process of finding knowledge in data and, simultaneously, give emphasis to a great application, in particular to Data Mining (DM). In fact, the DM concept corresponds to a variety of mathematical modeling techniques and software tools that are used to find patterns in the data, allowing the construction of models (Schafer 2005). In the context of recommendation applications, the term is also used to describe the collection of analytical techniques used to infer rules of recommendations or even build models of recommendations from a broad set of data.

In the effort to develop a system of evaluation, e.g., the Quality of Interaction (QoI) of LMS users, intelligent systems can play an important role, i.e., can provide a model of the domain expert's evaluating system, using advanced features and adaptive functionality (Levy and Weld 2000). The main design consideration of such systems is the acquisition of the specific knowledge of the domain in which they work, i.e., the construction of a knowledge base that contains the evaluation rules and information, upon which the evaluation inference takes place. In this line, a series of techniques are applicable (Beck and Stern 1999), such as machine learning (Sison and Simura 1998), with the potentiality of rule extraction from empirical data, or Bayesian networks (Gertner et al. 1992), for reasoning in a principled manner about multiple pieces of evidence. Such techniques, however, exhibit efficiency upon well-determined categories of information and the existence

of appropriate mathematical tools; this, however, is not well suited for dealing with uncertain systems, such as modeling of human behavior during the LMS interaction, where conventional functions cannot be used to model it.

Amongst the many methodological approaches applied to the field of DM the one of *Fuzzy Logic* (FL) is presented here, as it is that which was used in the case study of Chap. 10 (Part III), introduced by Zadeh (1965). FL can model the imprecise and qualitative knowledge, as well as the transmission and handling of uncertainty at various stages of our real life. FL allows modeling of the evaluating system under consideration, on the basis of its linguistic descriptions provided by the domain expert (Kosko 1994; Tsoukalas and Uhrig 1996). More specifically, by using the natural language to express the required knowledge, the expert uses a number of IF/THEN fuzzy rules. In other words (Lee 1990):

> The dynamic behaviour of the fuzzy system is characterized by the set of linguistic description rules based on expert knowledge. The expert knowledge is usually of the form: IF (a set of conditions are satisfied) THEN (the set of consequences can be inferred) (p. 407).

Within the syntax of these rules the expert uses linguistic variables to describe the specific behavior under evaluation. At the analytical level, however, the values of these variables can fall into some categories, yet instead of either being or not being an element of a category, they can be an element to a certain degree, justifying the basic principle of FL that "everything is a matter of degree" (Kosko 1994, p. 18). In this way, FL allows successful modeling of ill-defined, complex systems, without employing precise quantitative analyses (Beck and Stern 1999). The major advantage of the FL concept is that it manages to transform this knowledge from the linguistic to a background analytical level, where mathematical computations take place. Thus, driven by the expert's knowledge base, a fuzzy inference system (FIS) could be developed modeling his/her evaluating system; hence, providing evaluative inferences upon incoming information, on the basis of appropriate computations.

Despite the vast applications of FL seen so far in many research fields, the use of FL in the field of education has only gained significant attention the last decade. Gisolfi et al. (1992) and Fourali (1994, 1997) were from the pioneers who applied FL in the field of education for measuring student modeling and educational achievement, respectively, foreseeing the FL contribution in the social sciences (Fourali 1997). Bassey (2001) has extended the notion of FL into the field of generalization, by proposing the idea of "fuzzy generalization" in educational research and across other social sciences. Other indicative examples of FL-based approaches in the field of education and collaborative learning refer to the work of Mullier (2000) and Kavčič (2001), for enhancing educational hypermedia; Kavčič et al. (2003), for student modeling based on fuzzy inference mechanisms; Barros and Verdejo (1999), Hadjileontiadou et al. (2003, 2004) for modeling peers' collaborative interactions during collaborative learning; Hadjileontiadou and Hadjileontiadis (2003), for efficiently modeling skills and beliefs in computer-mediated collaboration using neuro-fuzzy models; Gravani et al. (2007) for FL-based modeling of professional learning. Moreover, Hwang et al. (2004) proposed

a fuzzy system to evaluate the quality of educational Web sites by users' and experts' opinions. Ma and Zhou (2000) proposed a fuzzy set approach to assess the outcomes of student-centered learning. Capaldo and Zollo (2001) used FL to a rating problem in personnel assessment. Dweiri and Kablan (2006) presented an approach that employs fuzzy decision making for the evaluation of the project management internal efficiency. Within the concept of b-learning, Mendez and Gonzalez (2010) proposed the inclusion of a FL-based controller for an introductory control engineering course. Moreover, Fasel and Zumstein (2009) introduced a fuzzy warehouse approach for Web analytics, whereas Lin (2010) proposed a fuzzy evaluation model for prioritizing the relative weights of course website quality factors.

4.5.1 Fuzzy Inference System

Generically, a FIS integrates the following elements/modules (Weber and Klein 2003):

- input;
- fuzzification;
- inference system; and
- defuzzification,

with their graphical interconnection depicted in Fig. 4.1.

The expert's knowledge in the linguistic form of IF/THEN rules is transformed to the analytical level using the *fuzzy set* theory, which allows for the ambiguity of the natural language to be analytically represented, and is a generalization of the *classical set* theory (Tsoukalas and Uhrig 1996). According to the latter, a specific

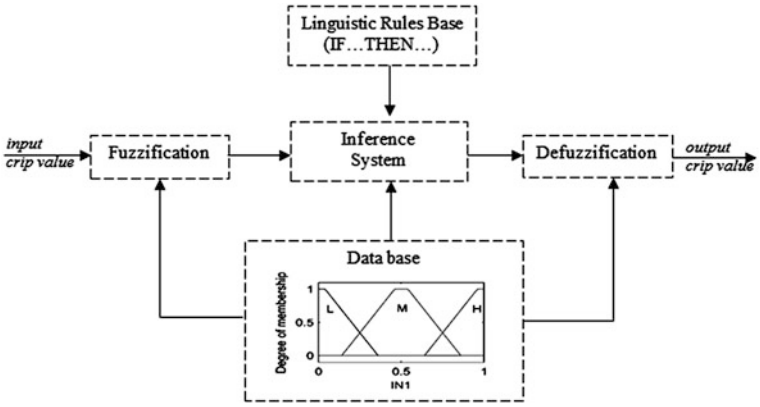

Fig. 4.1 Representation of a fuzzy inference system (FIS)

value of a fuzzy system (FS) parameter (e.g., input/output) might be either 'low' or not, on the basis of belonging or not, respectively, to a crisply defined set of values that can be characterized as 'low'. The fuzzy set theory allows all the values of the universe of discourse to be characterized as 'low', yet to a degree.

In this case, the pair of numbers {0,1} is generalized to the infinite numbers in the interval [0,1] and a function, called *membership function*, maps every element of the universe of discourse e.g., of 'view' to numbers in the interval [0,1], namely *fuzzy numbers* (again 0 and 1 denote zero and full membership to the set 'low', respectively). In a mathematical approach, a fuzzy set can be formally defined as follows (Tsoukalas and Uhrig 1996).

Let $\boldsymbol{X}$ be a set of objects, whose generic elements are noted by x. Membership in a classical subset $\boldsymbol{A}$ of $\boldsymbol{X}$ is often dealt with a characteristic function $m_A(x)$ such that

$$m_A(x) = \begin{cases} 1, & \textit{iff } x \in \boldsymbol{A} \\ 0, & \textit{otherwise} \end{cases}. \tag{4.1}$$

If the so-called valuation set {0, 1} is allowed to be the real interval [0, 1], $\boldsymbol{A}$ is called a *fuzzy set* and (4.1) takes the form of

$$\mu_{\mathrm{A}}(x) : \begin{cases} = 1 & \text{if } x \text{ is fully included in } \boldsymbol{A} \\ \in (0,1) & \text{if } x \text{ is included in } \boldsymbol{A} \text{ at a degree} \\ = 0 & \text{if } x \text{ is not included in } \boldsymbol{A} \end{cases}, \tag{4.2}$$

where the membership function $\mu_A(x)$ is the grade of membership of x in $\boldsymbol{A}$.

Thus, $\boldsymbol{A}$ is a subset of $\boldsymbol{X}$ which has no sharp boundary and the closer the value of $\mu_A(x)$ is to 1, the more x belongs to $\boldsymbol{A}$. As a consequence of this definition a fuzzy set $\boldsymbol{A}$ is completely characterized by the set of pairs

$$\boldsymbol{A} = \{(x, \mu_A(x)), x \in \boldsymbol{X}\}. \tag{4.3}$$

Through (4.2), infinite degrees of membership are possible, providing flexibility to the mapping of interest. The use of the membership functions distinguishes the fuzzy set theory from the classical one, allowing the classification of the fuzziness of a set, i.e., modeling of the uncertainty involved in its definition.

The definition of the membership functions and the analytical form of IF/THEN rules constitute the knowledge base of FIS. As it is evident, the construction of the latter is a prerequisite for the inference procedure, as it holds the knowledge upon which the evaluation takes place. Its content may vary, reflecting the relevant variations in the evaluation systems of different experts; this fact, however, does not diminish the value of the proposed approach, which focuses on the enhanced characteristics of the FL technology for the development of the expert evaluating system of interest.

The crisp values of the input variables to a FIS are interpreted as fuzzy numbers on the basis of the membership function mechanism. In this vein, linguistic parts of the IF/THEN rules are substituted by fuzzy numbers, upon which the mathematical computations at the analytical level take place. More specifically, the fuzzy

numbers of the antecedent of the rule are combined through union or intersection according to the OR/AND operators, respectively, that may be used in the syntax of the rule, respectively, to produce a new fuzzy number. Note that the union and the intersection of two fuzzy sets $\boldsymbol{A}$ and $\boldsymbol{B}$ (both contained in $\boldsymbol{X}$) are defined as

$$\mu_{A\cup B}(x) = max(\mu_A(x), \mu_B(x)),\ x \in \boldsymbol{X}, \tag{4.4}$$

$$\mu_{A\cap B}(x) = min(\mu_A(x), \mu_B(x)), x \in \boldsymbol{X}. \tag{4.5}$$

When the antecedent of a rule is satisfied, the rule is activated (fired) and the IF/THEN implication operator combines the fuzzy number of the antecedent with the consequent part, to produce the overall output of the rule. The outputs of the fired rules are then aggregated to produce the evaluation inference of interest. The fuzzy output of the inference procedure is then transformed into a crisp value through a defuzzification process, which usually involves the 'center-of-mass' (or centroid) z_c of the aggregated output $\mu_{\mathrm{Ag}}(x)$ given by (Hines 1997)

$$z_c = \frac{\int_X \mu_{\mathrm{Ag}}(x)xdx}{\int_X \mu_{\mathrm{Ag}}(x)dx}. \tag{4.6}$$

The obtained crisp value z_c of (4.6) provides with the quantitative evaluation of interest.

In the example of Fig. 4.2, the FIS is defined by means of two inputs (IN1, IN2) and one output (OUTPUT) and its knowledge base is formed by the membership functions in the form of a trapezoid, represented on the top panel of Fig. 4.2 (L, M, H refers to the values Low, Medium and High of all variables of the FIS, respectively) and four rules IF/THEN, that is, 1: IF (IN1 is Low) and (IN2 is Medium) THEN (OUTPUT is Medium); 2: IF (IN1 is Low) and (IN2 is High) THEN (OUTPUT is Medium); 3: IF (IN1 is Medium) and (IN2 is High) THEN (OUTPUT is High); and 4: IF (IN1 is Low) and (IN2 is High) THEN (OUTPUT is Medium). When the crisp values (IN1 = 0.28; IN2 = 0.705) are presented as inputs to the FIS (Fig. 4.2-bottom panel), the referred four IF/THEN fuzzy rules are fired accordingly and through their application to the membership functions, i.e., through correspondence AND to the MIN operator, resulting in the estimated crisp output value (OUTPUT = 0.576), which corresponds to the centroid (indicated by vertical lines) of the output aggregated membership function (Fig. 4.2).

In general, the choice of FIS type of analysis depends on the specific application criteria that reflect expert knowledge in system modeling (Tsoukalas and Uhrig 1996). Figure 4.1 presents an example of the construction of a Mamdani-type FIS with three inputs and one output, that models the IF/THEN expressions by applying minimum and maximum for the mathematical operators for the logical link "AND" and "OR", respectively, uses the minimum as a means of implication and returns the centroid of the output fuzzy region as the crisp output (defuzzification) of the FIS (see Fig. 4.3).

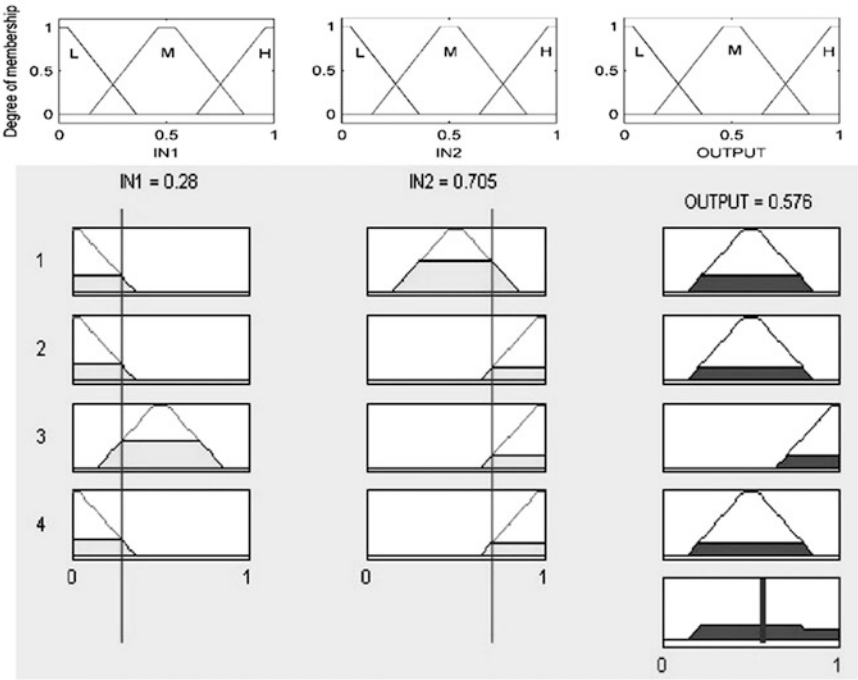

Fig. 4.2 An example of a FIS with two inputs (IN1, IN2) and one output (OUTPUT)

4.6 A Breviloquent Perspective

Along with choosing appropriate strategies for data collection, as presented in this chapter, the complex processes of managing, preparing, and analyzing the acquired data should be addressed. From a qualitative analysis point of view, these processes occur dialectically throughout the conduct of a qualitative study, rather than discrete and/or sequential events. To this end, the analysis occurs as themes are identified, as the deeper structures of the social setting become clear, and as consequent modifications are made in the initial design. The combinatory involvement of quantitative analysis fulfills the spherical view, equipping the conclusions with statistical reliability; hence, enhancing their power of generalization.

From the aforementioned perspective, the next chapter (Chap. 5) focuses on data preparation and implementation issues that contribute towards the efficient data analysis and treatment, which are described in Chap. 6.

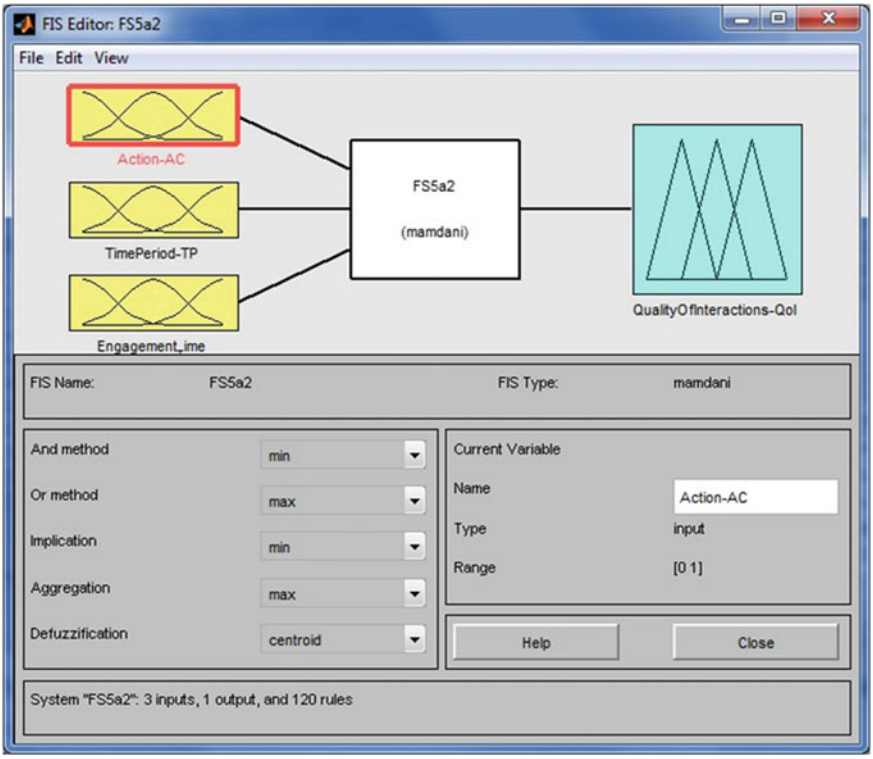

Fig. 4.3 An example of the configuration of a Mamdani-type FIS with the graphical user interface of the fuzzy logic toolbox of Matlab 2012b (http://www.mathworks.com) (refer the case study of Chap. 10 for the definition of the corresponding inputs and output)

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Chapter 5
Data Preparation and Implementation

5.1 Introduction

Following the sequence of steps initiated with the appropriate strategies for data collection presented in Chap. 4, the present chapter refers to the data preparation and implementation procedures that were involved in the exemplified case studies of Part III. The subheadings structure of the strategies presented in Chap. 4 is also adopted here, to facilitate comprehension and direct correspondence.

Although these procedures link to specific case studies, they also reflect a general character of data handling before further treatment; hence, they could contribute to the process of data analysis, in general.

5.2 Documental Analysis Data

When dealing with documental analysis data within a range, a categorization process should first take place, according to their sources, i.e., primary (historically contemporary and/or first-hand accounts) or secondary (historically or spatially distant and/or second-hand accounts) (Rapley 2008).

Furthermore, the *local content* of the documents should be considered, as they always are engaged within a specific framework, i.e., always read or used in a specific way, to do specific work. This could shift the focus upon questions about the immediate here-and-how context, or the immediate setting, the people and the evolving situation, for example.

As an extension, a focus on document-in-use can stimulate questions about "how the actions and interactions are embedded in and *produce broader, extra-local, contexts and structures*" (Rapley 2008, p. 90). Characteristic examples can include questions like: "What course is this document part of? Why are you reading this document? How is it that qualitative research is seen as valuable in some courses/disciplines and not others?" This style of questions refers to an approach of the documental analysis beyond the immediate here and now of the

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(inter)actions that are observed, leading to the collection of supporting information outlined by broader perspectives (e.g., historical, political, ethnographical, contextual). In this way, features like the materiality of documents and the immediate and broader contexts could be identified and used in the documental data analysis.

The documental analysis adopted in the case studies of Chaps. 7–9 followed the aforementioned guidelines and considered the contextual perspectives, both at the local and extra-local nature. In this way, the interconnection among the local singularities with the more global causes is achieved, contributing to the objective approach of the underlying trends, profiles and modeling perspectives.

5.3 Survey Data

The study of the appropriateness of an instrument—and here appropriateness refers to examine its reliability and validity—is crucial. During the survey process construction, a theoretical framework in each set of *variables components*[1] has to be considered, in order to try to check its validity (*construct validity*), taking into account the experts' knowledge in the area (e.g., in the area of Research Methodologies). Moreover, with regard to validity of the survey answers, an adequate writing of all questions involved in the survey has to be made (*face validity*).[2] In addition, concerning internal reliability, Cronbach's Alpha coefficient should be measured. The latter should be above 0.7 and below 0.9 (Hill and Hill 2000). To enable the calculation of the consistency of the responses, a repetition of questions can be made. On the other hand, there are always doubts about the validity and reliability of responses (since the questions in general reveal attitudes, likes/dislikes, satisfactions or values). According to Hill and Hill (2000) a measure can have good reliability and validity, yet, without adequate reliability, the measure may not have adequate validity.

According to the above perspectives, the survey designed as a data collection instrument for the case study of Chap. 7, adopted a clear theoretical framework for each variables set, involving comprehensive set of questions, adequately validated by the experts in the field of educational research, and used to collect data regarding students' opinion about the use of OLEs, as users of LMS Moodle. In particular, the survey was organized into five distinct parts (see Appendix B). In the first part was to essentially collect general information of students (gender, age, and email). The second part aimed at collecting data regarding students' opinions about the use of OLEs; more specifically: LMS Moodle usability, characterization of available online tools, and the type of communication tools used. The third part

[1] According to Hill and Hill (2000), variables components can be measured from questions/items of a survey.

[2] However, it is important to have in mind that it is rarely possible to demonstrate the validity of responses (Hill and Hill 2000).

intended to collect information about the role of the Teacher in the LMS Moodle, whereas the fourth part about the role of the Student in the LMS Moodle. Finally, the fifth part designed to collect data concerning students' perspectives on the need to use different online communication tools and their purpose.

For the sake of keeping the responses complexity in reasonable levels, the questions used were essentially of closed, dichotomous choice (Yes/No) and multiple-choice type. A numerical scale of agreement with four different Likert levels (1-Agree; 2-Agree more than Disagree; 3-Disagree more than Agree; 4-Disagree) and one undecided level (No Opinion), were considered. It should be noted that to check the accuracy of the hypothesis under consideration using the χ^2 statistic test, the effects in the contingency table should be taken into account. Contingency tables are constructed by listing all the levels of one variable as rows in a table and the levels of the other variables as columns, then finding the joint or cell frequency for each cell. The cell frequencies are then summed across both rows and columns and the sums are placed in the margins, the values of which are called marginal frequencies. The effects in the contingency table are defined as relationships between the row (i) and column (j) variables; that is, are the levels of the row variable differentially distributed over levels of the column variables. Significance in this hypothesis test means that interpretation of the cell frequencies is warranted; non-significance means that any differences in cell frequencies could be explained by chance (Gray and Kinnear 2012). Estimating E_{ij} as the *expected cell frequency* for each cell, by multiplying the marginal frequencies for the row and column of the ij-cell and then dividing by the total number of observations N, the following assumptions should be taken into account (Maroco 2003):

- N should be more than 20;
- all E_{ij} are greater than 1; and
- at least 80 % of E_{ij} are equal to or greater than 5.

If the above assumptions do not hold, the Likert scale can be adjusted, for instance, to two levels, i.e., 1-Agree (sum of item 1 and item 2) and 2-Disagree (sum of item 3 and item 4).

Furthermore, the responses "Agree" and "Agree more than Disagree" were considered to represent positive statement (attitude), and in opposite, the answers "Disagree more than Agree" and "Disagree" were considered to indicate negative statement (attitude), revealing the concern in using the equity principle (Hill and Hill 2000). Kumar (2005) in this respect adds the following:

> It is important to remember that the Likert scale does not measure attitude *per se*. It does help to place different respondents in relation to each other in terms of the intensity of their attitude towards an issue: it shows the strength of one respondent's view in relation to that of another (p. 146).

The construction of the survey in an online version often facilitates the data handling, as the responses are directly archived in a database, accelerating the whole process of data collection and categorization. Moreover, sometimes, the themes and general objectives of a survey are proved to be quite complex (like in

the case study of Chap. 7). To this end, the survey can be accompanied by a complementary data collection instrument, such as an interview; data preparation and implementation issues of the latter are discussed in the succeeding section.

5.4 Interview Data

As mentioned in Sect. 4.4, the semi-structured interview method is considered as being rich in heuristic potential. Sometimes, however, it is subjected to the intrusive effects of interviewer bias, both during the interview and in the analysis of content. This bias can affect significantly the credibility of theory building from qualitative data. Nevertheless, several tactical approaches can be adopted to limit such bias, i.e. (Miles and Huberman 1994):

- an interview guide could be designed with the aim of ensuring complete and consistent coverage in each interview of themes under study, as well as minimizing the researcher's intrusion through the pre-specification of neutral questions and probes;
- a systematic auditable process can be used to develop theoretical propositions from the qualitative data. This process adds to the development of an audit trail from transcribed text to the development of propositions; and
- structured questions could be employed provided a participant-rated quantitative response not only on established scales, but also, more tentatively, on variables evaluated primarily using qualitative data. These participant-rated data could be used for testing the convergence with the findings based on the analysis of qualitative data.

Linking to the case studies of Chaps. 7–9, the interview was the data collection technique that seemed more relevant for understanding the thinking and views of users (teachers and students) about the LMS Moodle use. In fact, the interview was designed to seek elaborated responses and the structured questions were designed to elicit scaled responses on the research questions. The construction trajectory followed was based on the theoretical framework and prior context (documental) analysis (through e.g., the analysis of statistical reports, activity type, access, contributions, and views), from which, initially, the objectives to be achieved with the implementation of the interview were defined. Posteriorly, the main themes and corresponding guide-questions were formed.

More analytically, three different interview guides (see Appendices C, D, and E, respectively), representing self-contained themes, were constructed, as an outcome from an intensive work of reflection and collaboration of experts in the field of research methodologies and educational technology. Two test interviews were also performed, in order to validate the use of the respective interview guide. In general, the need for some adjustments of specific issues initially designed was verified. Hence, the three interview guides were subjected to progressive refinement revisions up to the respective final versions.

The preparation of the structured interview was based on three distinct parts:

- Part A-Introduction: all participants were informed about the main research issues and conditions/procedures of the interview (e.g., audio-recorded interview, guarantee of anonymity). Additionally, some particular data that had as intention to demographically characterize the participant (e.g., gender, age) were also acquired.
- Part B-Development: all information around the major themes was collected. For each of these themes, a discussion upon core issues took place, which started as an interactive dialogue, being only interrupted when particular subcategory needed more clarification.
- Part C-Conclusion: represented an open space to each participant to add any extra/relevant information to the study, if needed. The interview ended with special gratitude and final considerations.

All interviews were audio-recorded and transcribed in full. Transcripts were sent to participants for any reformulations and after verification they were coded (see Sect. 6.4). Since it was intended to ensure the anonymity of respondents, the latter were corresponded to "Teachers#" or "Students#", accordingly. Also, seven interviews were randomly conducted, in order to test the reliability of the process.

The interview guides were designed with the dual aim of avoiding bias and ensuring adequate reporting within the frame of reference of the study (Brenner 1985). With the structures adopted, the bias through the pre-specification of non-directive questions and probes was tending to be minimized. Actually, such pre-conditioning reduces the tendency to resort to unplanned, non-neutral probes whilst in the field (McCracken 1988). The design of the interview guides ensured completeness in covering the terms of reference of the study in each interview. In order to elicit full and undirected accounts from participants on the themes under study, a flexible design in the interview guides was adopted (Brenner 1985). Additionally, the guides did not require that questions be addressed in a particular order. The pre-specification of questions and probes on each theme assisted in maintaining a non-directive stance, even if used in a different order from that indicated in the guides.

5.5 From LMS to FIS Data

To better understand the nature of the LMS data, the focus is placed here upon the LMS role, functionality and contributed outputs. Apparently, in modern e-learning platforms, the main contributors in these systems are the "learners" and the "authors"; others include trainers and administrators. Authors (which may be teachers or instructional designers) create content, which is stored under the control of a LMS, typically in a database. Existing content can be updated and it can also be exchanged with other systems. The LMS is managed by an administrator, and it interacts with a runtime environment that is addressed by learners,

who in turn may be mediated by a trainer. The primary objective of the LMS is to manage learners, keeping track of their progress and performance across all types of training activities. The LMS manages and allocates learning resources, such as registration, classroom and instructor availability, instructional material fulfillment, and online learning delivery.

The benefits of the LMS are twofold. First, by distributing materials electronically and nearly instantaneously, an LMS facilitates the creation and dissemination of course materials that otherwise would need to be dispensed during class time. An LMS also allows for the creation of unique learning environments that can supplement in-class activities, empowering both students and instructors to reinforce the course material and to engage with the material in a variety of ways (Dougiamas and Taylor 2003).

So far, the development of LMS technologies, it remains less clear, however, just what the comprehensive benefits of an LMS might be, how these benefits can be measured, and what a completely successful implementation of an LMS would look like. Nevertheless, the use of such systems is nearly ubiquitous, and colleges and universities support them for both their pedagogical and administrative benefits. At the extremes, the LMS might be considered simply an instructional learning tool, as commonplace as chalk or it might be the harbinger of pedagogical benefits that fundamentally alter the way teachers teach and learners learn. Presumably, if all parties can be made aware of how LMSs can impact teaching and learning, the benefits can be maximally refocused and refined.

Most generally, the primary claims, functions, and implementations of LMS technology can be divided among three broad categories (Sclater 2008), which, naturally, produce the analogous data, i.e.:

- transmission, which aids in distributing and accessing course material;
- evaluation, which aids in identifying different learning patterns for students and educators; and
- interaction, which establishes unique learning environments for the applied practice of specific exercises.

More specifically, usage patterns and self-reports by educators almost universally demonstrate that the LMS is most frequently used for the transmission of the lecture notes, slides, or course handouts that instructors typically distribute to students in class (Nijhuis and Collis 2003). As such, the marshaling of an LMS for the purpose of transmission is the feature most analogous to "unplugged" pedagogical practice. The LMS, however, empowers students to engage with the material at any point in time. Thus, educators have an opportunity to refine, update, and augment the materials, not only before a given class has begun, but also during and after, reinforcing curricular goals during each of these periods (Georgouli et al. 2008). Moreover, an LMS helps to standardize material across instructors and course sections, while giving enough flexibility for each instructor to provide his or her own additional reference materials and tailoring the course for the varied learning differences of students.

One of the benefits of the LMS is that it provides users with a built-in opportunity to reflect critically on the utility of the LMS to their teaching or learning. Most LMSs come preconfigured with some kind of analytic software, which allows faculty to track which students have visited the LMS domain, how often, and which materials they have accessed. This can help instructors to monitor not only what students are doing on the LMS, but also how they are doing it, what difficulties they are encountering, and how this information relates, transparently, to that of their peers (Graf and Liu 2009). Although "evaluation" in this sense refers to the actual activity that students and instructors are undertaking, LMSs can likewise be deployed as automated evaluative tools, e.g., by monitoring students' interactions in an LMS environment to construct more efficient groupings for in-class activities. This, in effect, is the purpose of all LMS evaluation -to seek out differences in students' learning ways in order to isolate optimally effective pedagogies. It would follow that one of the most vital components of an *intelligent* LMS is to offer the tools for evaluation of the LMS itself; the evaluative function is what renders LMSs so adaptable.

Regardless of educational philosophy, LMSs can promote learning only to the degree that students interact with them. The most common method of LMS interaction is the online discussion board (Dougiamas and Taylor 2003), a tool that, even historically, has shown ample opportunity to foster interaction between students, but the tool itself does not compel students to ask questions of one another. The motivation to use the tool must come from the instructor (as is the most likely case) or from the students themselves. In addition, from faculty self-reports, many studies have found that the features of any given LMS that allow instructors to create interactive learning activities are the least utilized feature overall (Woods et al. 2004). Although faculty members state that their primary motive for using LMSs is to improve pedagogy, studies show that faculty tend to use only those features that transmit information most efficiently (Nijhuis and Collis 2003). Regardless of whether it is presently achieved, interaction provides the most novel sequence of end-user experiences, and it marks the fullest potential for LMSs to introduce teaching and learning strategies that are otherwise inconceivable in the real world. It is important to note that the mechanisms discussed here provide only a cursory view of the possible applications and permutations of what an interactive system might be. Indeed, the versatile capacity for LMSs to apply inventive pedagogies might be considered a metaphor for the LMS itself.

Stemming from the latter concept, the key-parameters and variables (metrics) of LMS Moodle involved within a b-learning environment concerning the user's interaction with the system could be organized in such a way so to be fed as inputs to a FIS (or a series of FIS) structure (Tsoukalas and Uhrig 1996); subsequently, the outputted inference can form a quantitative measure of the user's overall QoI (see also Sect. 6.5 and Chap. 10 , for detailed description of the FIS structure and performance efficiency, respectively).

A typical LMS Moodle includes 110 metrics that relate with the user's activity in the system and theoretically could all be used as input variables to the FIS structure. This number of variables, however, results in great difficulty for the

Table 5.1 The 12 basic categories derived from the LMS Moodle data and used as input variables to the FIS structure of Sect. 6.5

Categories (Abbreviation)
Journal/Wiki/Blog/Form (J/W/B/F)
Forum/Discussion/Chat (F/D/C)
Submission/Report/Quiz/Feedback (S/R/Q/F)
Course Page (CP)
Module (M)
Post/Activity (P/A)
Resource/Assignment (R/A)
Label (L)
Upload (UP)
Update (U)
Assign (A)
Edit/Delete (E/D)

expert to express, linguistically, the evaluation rules upon them all, since the larger the number of the linguistic variables becomes, the more complicated the knowledge acquisition process is. As a remedy to this situation, a categorization of the 110 LMS Moodle metrics into 12 basic categories, in which the summation of the metrics belonging to the same category defines the value of the corresponding variable, could significantly reduce the number of the input parameters involved in the FIS structure (for analytical correspondence refer to Table 6.1). This approach allows *all* metrics to be employed in the inference process, creating fuzzy variables that act either as *initials* or as *intermediates* (see also. Sect. 6.5).

Table 5.1 tabulates the 12 basic categories used as input variables to the FIS structure. Note that, apart from the input variables of Table 5.1, two additional LMS Moodle parameters, i.e., Time Period (TP) and Engagement Time (ET), have also been used in the FIS structure (see Sect. 6.5).

5.6 Overview

The data preparation and implementation issues discussed in this chapter have established documental analysis, survey, interview and FL-based data mining as the core data collection and handling techniques incorporated in the artifacts analysis within the OLE examined in this book. The complementary character of these techniques empowers the information behind the acquired data and provides wide potentialities to unveil underlying trends, profiles and behaviors by adopting efficient treatment and analysis approaches, as explained in the succeeding chapter.

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Chapter 6
Data Treatment Techniques

6.1 Introduction

After the data acquisition strategies and the preparation/implementation issues discussed in Chaps. 4 and 5, respectively, the present chapter refers to the data analysis procedures that are involved in the exemplified case studies of Part III. Similarly to the previous two chapters, the subheadings here also follow the same structure to facilitate comprehension and direct correspondence.

As explained in Sect. 4.1, the treatment of the data collected involves quantitative and qualitative techniques. Kumar (2005) suggests that a research study may be more beneficial when working with both techniques, providing a more detailed/completed examination of particular dimensions that belong to the same reality. Despite the referential character to the specific case studies of Part III, the techniques of this chapter also contribute to the process of data treatment from a general perspective of the OLEs analysis spectrum.

6.2 Documental Analysis

Following the lines of Sect. 5.2, it is deduced that documental analysis could offer an efficient way to globally characterize and contextualize the OLE environment. To this end, documents from the LMS Moodle archive with the objectives of:

- characterization of active disciplines with regard to Activities, Structure and Content; and
- analysis of communication tools used by teachers,

could be analyzed and numerically codified, accordingly, so to be subjected to statistical quantitative analysis (see Chap. 7).

Moreover, some data directly drawn from LMS Moodle could be used for providing graphical representations (e.g., access, activity, view, contribution), as well as some statistical reports, automatically performed by the LMS Moodle. In addition, using the LMS Moodle platform, some information can electronically

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be collected regarding the demographic characteristics of each user (e.g., gender, age, first access, peak of activity).

Furthermore, through the Website of Google Analytics[1] some metrics and specific views of the LMS Moodle traffic logs can also be analyzed. Overall, this documental analysis has as main goal to characterize visitor's traffic trend in LMS Moodle, in a longitudinal fashion.

Some data concerning particular characteristics of teachers and students in their courses can also be collected from the LMS Moodle platform. From the data collected it is possible to distinguish on the one hand, the sample in two distinct groups (more or less active user—student/teacher), and on the other hand, identify differences among the courses regarding the number of individual records, views, contributions and activity type performed in the LMS Moodle.

All the above data, by being archived in a database, can form the documental data analysis corpus (see Chap. 7).

6.3 Survey

As it was mentioned in Sect. 5.3, online version of a survey facilitates the data handling. For the construction of an online survey instrument an open source tool, such as LimeSurvey,[2] can be used. Among others, this easy and free application has some advantages, allowing users to:

- create unlimited number of questionnaires of participants from various languages;
- choose multiple types of questions;
- form a paper version;
- create public questionnaires;
- made invitations/notices by email;
- present the results of the questionnaires in graphs/tables;
- export data to statistical analysis software.

The ability to export the data in different formats (e.g., in `.xlsx`, `.docx`, and `.sav`), facilitates the organization and further analysis of the data.

6.3.1 Inferential Statistical Analysis

An inferential statistical analysis could be performed (see Chap. 7), by the association of some variables that are part of the survey online questionnaire, in order to explore the following hypotheses:

[1] From http://www.google.com/analytics/

[2] From http://www.limesurvey.org/

- H1: the use of more innovative communication tools depends on the facility to use the LMS Moodle platform;
- H2: the satisfaction level of students concerning their use of the LMS Moodle platform is related to their autonomy to develop their work; and
- H3: the efficiency of the LMS Moodle platform depends on the teacher's performance as moderator, particularly regarding the quality and effectiveness of the information shared with the students.

In order to test the aforementioned hypotheses H1–H3, contingency tables (crosstabs) and Chi square (χ^2) test of independence can be conducted (refer also to Sect. 5.3). Being a non-parametric statistical test, χ^2 is often adopted when investigating the existence of dependency between two categorical/nominal types of variables (Gray and Kinnear 2012). It should be noted that the dependency between the two variables only means that the two variables are related, not specifying the type of relationship. Thus, the independence test made it possible to test the hypothesis that the variables placed in i lines and j columns of contingency tables are associated (or not), verifying that the differences in the observed proportions (O_{ij}) exceeded the expected (E_{ij}), adopting the assumptions of Sect. 5.3.

For the specific cases of H1–H3, the cells of the contingency tables could be formed accordingly:

- H1 case: (i-innovation in the context of communication tools usage, j-the facility of the use of the LMS);
- H2 case: (i-students' satisfaction concerning the use of LMS, j-autonomous capacity of work performed by students);
- H3 case: (i-LMS efficiency, j-the role of the teacher in the LMS).

The statistical significance of associations can be verified from the application of χ^2 test of independence, with *Yates' correction* (Calder 1996), to the contingency tables of cases H1–H3, considering a significance level of 0.05 ($p < 0.05$).

6.4 Interview

The data from the interview (see Sect. 5.4) can be used to design and structure a set of open questions, in order to analyze in-depth some dimensions that are not, initially, identified by the documental analysis and the survey. To this end, the content analysis that follows could be adopted.

6.4.1 Content Analysis

The development of qualitative research has revealed distinct perspectives, contributions and challenges in promoting new movement of ideas, practices and

techniques of research, particularly in the humanities and social sciences. The content analysis, seen as a set of techniques of analysis of communications/messaging, emerges as a (multi-) functional/purpose instrument, strongly influenced by the art of understanding and interpreting texts. According to Bardin (2009), the common factor of these techniques—from the calculation of frequencies that provides data encoded, to the extraction of translatable structures in models—it is based on deduction hermeneutics, i.e., the inference. In other words, the content analysis oscillates between the two poles: the rigor of objectivity and the fertility of subjectivity. From this perspective Flick (2009) adds the following: "Analyses in objective hermeneutics must be 'strictly sequential': one must follow the temporal course of the events or the text in conducting the interpretation" (p. 350).

Furthermore, the technique of content analysis has been provoked and complemented with two strong trends; on the one hand, *the desire of accuracy* (also called prudent verification) and on the other hand, *the need of discovery* (also called brilliant interpretation) (Bardin 2009). In fact, there are two procedures that differentiate the content analysis of other techniques:

- the first procedure refers to the analytical description, i.e., the description of the features that are in a text, which are essential for the purpose of the study, and may also be associated with a synchronous plan (*horizontal*); and
- the second procedure tries to give meaning and interpretation to the characteristics, i.e., invokes inference (the process of logical deduction), and it can be designed in a diachronic perspective (*vertical*).

In this way, the analysis of message-content as a means of communication, on the one hand, allows to enrich the exploratory effort of discovery (*heuristic role*); on the other hand, it might serve as evidence, through hypotheses/questions that are subjected to verification for confirmation or infirmation (*role of administration of proof*) (Bardin 2009).

Taking into account the abovementioned, a categorical analysis using the semantic categorization criteria, grouping the thematic categories can be used. In turn, the process of systematization and organization of the analysis of the content can be realized in sequential steps; more specifically (Bardin 2009):

- Step 1: Pre-analysis (organization and systematization of ideas);
- Step 2: Material exploration;
- Step 3: Processing of results; and
- Step 4: Interpretation.

In addition, some authors still systematize the use of this technique in four distinct processes, i.e. (Cohen et al. 2007):

> Put simply, content analysis involves coding, categorizing (creating meaningful categories into which the units of analysis-words, phrases, sentences, etc.—can be placed), comparing (categories and making links between them), and concluding—drawing theoretical conclusions from the text (p. 476).

Content analysis can often be facilitated with the support of dedicated software, for example MAX Qualitative Data Analysis (MAXQDA) (http://w ww.maxqda.com/). Generally speaking, this software incorporates tools that serve as support for the qualitative data analysis process, minimizing the effort and the time devoted to operational tasks that the computer may, satisfactorily and effectively, perform. In this way, the data content analysis becomes more systematic, since the management of a wide amount of data is facilitated. Moreover, great flexibility is provided through, e.g., the ability to move codes, to drag-and-drop items, to automatically generate correlations and analytical descriptions, and to construct models of analysis. By creating a system of codes (code system functionality), for example, it is possible to build a categorical structure, assigning to each category and subcategory the numerical quantity of Text Units (TU). Defined during the encoding process, each TU corresponds to a unit of meaning (or a thematic unit according to the semantic level) of interviews, yet in the form of a word, a sentence or a paragraph.

Supported by the MAXQDA, the procedures for the realization of the content analysis of the interview data can include hierarchically (Cohen et al. 2007; Bardin 2009; Flick 2009):

- full reading of all interviews, in order to extract the main ideas and the particular characteristics of each respondent;
- definition of the units of analysis: (i) unit of text, and (ii) unit of context;
- construction of categories (code system) that served as a basis for the initial codification of the total of TU;
- codification of the TU (note that during the process new (sub)categories might emerge);
- reorganization of categories and subcategories in their final version;
- systematic analysis of the results from the categorization set; and
- interpretation of the results of the above mentioned analysis based on indicators that have emerged within each category and subcategory.

In parallel to the aforementioned steps, validation of the identified categories with the help of experts in the field can be carried out, in order to ensure the accuracy of the process and the analysis/interpretation of the results obtained. Finally, a system of coded categories derived from a progressive classification of TU can be formed, as the example given in Fig. 6.1.

From the categorical structure a statistical analysis can be applied for each category and corresponding subcategories, in order to consider the relative importance that each has in relation to the totality of TU of interviews. The latter can be articulated with multivariate analysis, involving the technique of Multiple Correspondence Analysis (MCA), described in the next subsection.

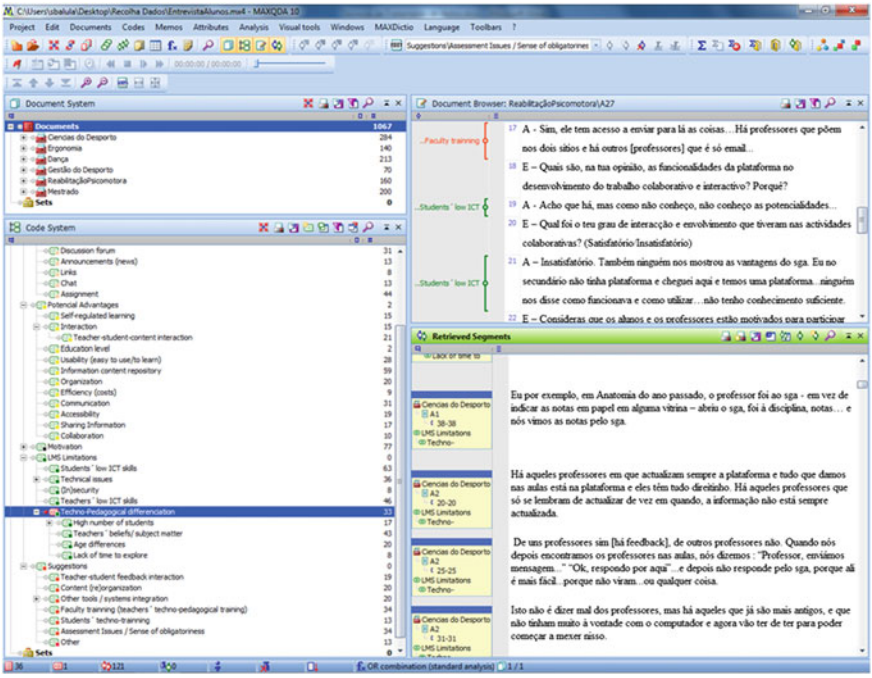

Fig. 6.1 An example of the system of coded categories using MAXQDA. The organizational interface of MAXQDA is divided into four particular windows, i.e., document system, document browser, code system, and retrieved segments

6.4.2 Multivariate Analysis

The correspondence analysis (CA) is considered an exploratory data analysis technique suited to analyze two-input tables (simple CA) or multiple input tables (MCA). In this context, some advantages of simple CA are described by Clausen (1998):

> The main purpose of correspondence analysis is to reveal the structure of the complex data matrix by replacing the raw data with a more simple data matrix without losing essential information. This implies removing 'noise' or redundant information (…) it possible to present the result visually, that is, the points within the space, which facilitates interpretation (p. 1).

Also, the author suggests an interesting perspective of the analytical process of simple CA in order to clarify the whole process inherent to this technique (Clausen 1998):

> The first step is to calculate the categorical profiles (i.e., the relative frequencies or conditional proportions) and masses (marginal proportions). The next step is to compute the distances between the points. The problem is then to find the *n*-dimensional space that best fits the points (p. 4).

In general, the simple CA has an important advantage that convert an array of non-negative data on a particular type of graphic representation, where the rows and columns of the matrix are both represented in small size, i.e., points on the graph. According to Härdle and Simar (2003), the simple CA provides tools to analyze the association between the rows and columns of contingency tables and often is related to the problem of reducing the size of the table. Some authors also add that the graphical presentation of the results facilitates their interpretation and analysis (Clausen 1998; Blasius et al. 2009; Aşan and Greenacre 2011).

Interestingly, Roux and Rouanet (2009) introduced the technique of MCA, depicting an important paradigm of geometric data analysis. MCA seems to have particular advantages when categorical variables are used, identifying two distinct types of "clouds" (individuals vs. categorical variables of the table) (Roux and Rouanet 2009) (refer also to Chaps. 8 and 9). In fact, the MCA is a factorial method that displays categorical variables in a property space, which maps their associations in two or more dimensions. From a table of n observations and p categorical variables, describing a p-dimensional cloud of individuals ($p < n$), the MCA provides orthogonal axes to describe the most variance of the whole data cloud. The fundamental idea is to reduce the dimensionality of the original data thanks to a reduced number of variables (factors), which are a combination of the original ones. The MCA is generally used as an exploratory approach to unearth empirical regularities of a dataset (Benzecri 1992).

It is noteworthy that the concept of MCA resembles the one of cluster analysis, since both are classified as interdependence techniques. Nevertheless, it is essential to observe that MCA includes a categorical/nominal database, whereas, in contrast, cluster analysis involves continuous numeric data. With regard to the analysis of multivariate methods, specifically in the comparison of dependent and interdependent techniques, Mukhopadhyay (2009) argues that the interdependent methods are less explanatory and try to explain the underlying phenomena/structure of the data, often through data reduction. In turn, the MCA is a technique that analyzes the relationships and similarities between row and column categories set. As Roux and Rouanet (2009) state: "MCA is eminently apt at revealing the structural complexities of tables with a large number of variables, it synthesizes the host of analyses of two-way tables (variable × variable)" (p. 11).

Although considered as a descriptive/exploratory technique, MCA also indicates how variables in rows and columns are arranged/related (not only examining if this relationship exists). Nevertheless, when starting the data analysis and interpretation of particular concepts it is important to consider the following parameters and their interpretation:

- *Centroid*—the interpretation of the MCA follows the bary-centrique principle (also called geometric centre), which is based on the premise that the points next to each other are similar to each other. The center of gravity (centroid) is a weighted mean of the row and column profiles (Hoffman and Leeuw 1992; Clausen 1998; Roux and Rouanet 2009; Rencher 2002);

- *Chi square distance*—a variant of Euclidean distance, called the weighted Euclidean distance, is used to measure and thereby depict the distances between profile points. Here, the weighting refers to differential weighting of the dimensions of the space and not to the weighting of the profiles. The Chi square distance differs from the usual Euclidean distance in that each square is weighted by the inverse of the frequency corresponding to each term. A large Chi square distance indicates that two profiles are quite different (Clausen 1998; Rencher 2002);
- *Inertia*—also called variance, is directly related to Chi square distances (and analogous to variance and eigenvalues terms). In turn, the total inertia refers to the sum of the eigenvalues (Clausen 1998; Rencher 2002); and
- *Eigenvalues*—are based on the Kaiser criterion (Kaiser 1970). Eigenvalues indicate how much of the total inertia (variance) each factor explains. According to Clausen (1998), the number of eigenvalues that are identified is equal to the total number of dimensions. In general, the eigenvalues express the relative importance of the dimensions.

MCA is based on a singular value decomposition which provides eigenvalues. The latter give an indication of the quality of representation associated with each dimension (Fichet et al. 2011). That is, the eigenvalue can be seen as the total sum of squared component loadings in each dimension, i.e., the relationship between *Cronbach's alpha* and the total variance accounted for, as expressed in the eigenvalue (Kaplan 2004). Moreover, the inertia quantifies the explained variance by each dimension, ranging from 0 to 1. Note that as more closely the inertia appears to the upper limit, more variance is explained by the dimension.

In summary, the exploratory technique of MCA is especially useful in structural analysis of a multivariate and categorical data, reducing considerably the number of variables, as well as the inference and statistical recognition of particular paths or profiles in a community (see also Chaps. 8 and 9).

6.5 The *FuzzyQoI* Model

In the effort to develop a successful evaluating system of the user's interaction with the LMS through the QoI, intelligent systems may play an important role, i.e., provide a model of the domain expert's evaluating system, with the promise of advanced features and adaptive functionality (Levy and Weld 2000). Based on the latter, a Mamdani-type (Tsoukalas and Uhrig 1996) fuzzy logic-based QoI modelling, namely *FuzzyQoI* scheme, is described here. *FuzzyQoI* constitutes a FIS structure that is able to produce evaluative inferences upon input data. In particular, the latter correspond to the key-parameters and variables (metrics) of LMS Moodle involved within a b-learning environment concerning the user's interaction with the system, whereas the outputted inference forms a quantitative measure of the user's overall QoI (Dias and Diniz 2013).

As it was mentioned in Sect. 5.5, the 110 LMS Moodle metrics were corresponded to 12 categories (see Table 5.1) that serve as inputs to the FIS structure. In an effort to efficiently handle the 12 input variables, a nested sequence of five FISs is used to form the proposed *FuzzyQoI* scheme. A block-diagram of the latter is depicted in Fig. 6.2, whereas Table 6.1 (as extension of Table 5.1) tabulates the correspondence of the 110 LMS Moodle metrics to the 12 input variables of FIS1–FIS3.

From Fig. 6.2 it is clear that the FuzzyQoI scheme holds three levels of inference using five FISs, i.e., FIS1–FIS5. The first level includes FIS1, FIS2 and FIS3, which output the values of View (V), Addition (AD) and Alteration (AL), respectively, upon the initial variables {Journal/Wiki/Blog/Form (J/W/B/F) Forum/Discussion/Chat (F/D/C), Submission/Report/Quiz/Feedback (S/R/Q/F), Course Page (CP)} for FIS1; {Module (M), Post/Activity (P/A), Resource/Assignment (R/A), Label (L)} for FIS2, and {Upload (UP), Update (U), Assign (A), Edit/Delete (E/D)} for FIS3. In the second level of inference, V, AD and AL are considered as intermediate variables and are used as inputs to the FIS4, which outputs the value of Action (AC). Finally, in the third level of inference, the AC is considered as intermediate variable and along with Time Period (TP) and Engagement Time (ET) are used as inputs to the FIS5, which outputs the Quality of Interaction (QoI) as the final output of the FuzzyQoI scheme (Dias and Diniz 2013).

For the construction of the knowledge base of the *FuzzyQoI* scheme, an expert in the field of analyzing LMS Moodle data within the context of b-learning is used, for defining the structure of the membership functions used for each FS and the corresponding IF/THEN fuzzy rules. In particular, a three-level of trapezoid membership functions corresponding to Low (L), Medium (M) and High (H)

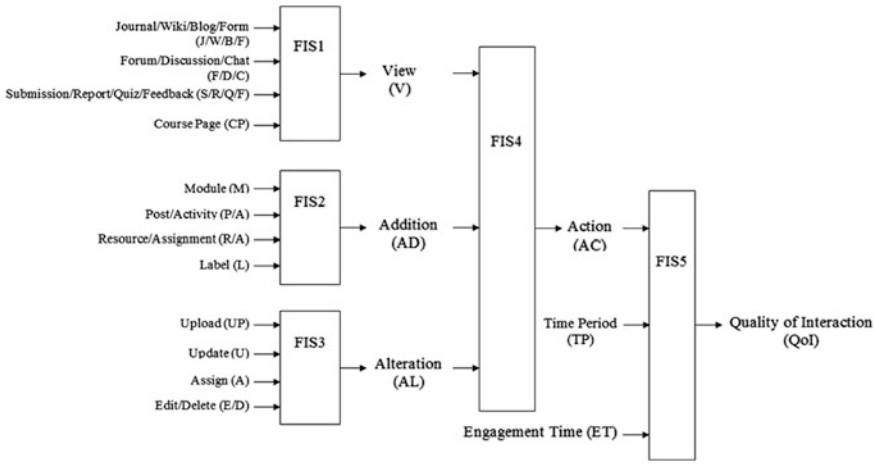

Fig. 6.2 Block-diagram of the proposed *FuzzyQoI* model, consisting by five fuzzy systems (FIS1-FIS5) in a cascaded mode. (Dias and Diniz 2013)

Table 6.1 Codification of all LMS Moodle metrics (in their original appearance) to the inputs of the FIS1, FIS2 and FIS3 of the *FuzzyQoI* model (see Fig. 6.2). (Dias and Diniz 2013)

FIS#	LMS Moodle metrics			Code#	FIS Input Name
	'Action'	Combination of 'Module' and 'Action'			
		'Module'	'Action'		
1	View all			4	Course Page (CP)
	View discussion			2	Form/Discussion/Chat (F/D/C)
	View form			1	Journal/VViki/Blog/Form (J/W/B/F)
	View forum(s)			2	Form/Discussion/Chat (F/D/C)
	View grade			3	Submission/Report/Quiz/Feedback(S/R/Q/F)
	View graph			3	Submission/Report/Quiz/Feedback(S/R/Q/F)
	View report			3	Submission/Report/Quiz/Feedback(S/R/Q/F)
	View responses			2	Form/Discussion/Chat (F/D/C)
	View submission			3	Submission/Report/Quiz/Feedback(S/R/Q/F
	View subscribers			1	Journal/VViki/Blog/Form (J/W/B/F)
	Preview			4	Course Page (CP)
	Info			1	Journal/VViki/Blog/Form (J/W/B/F)
	Links			1	Journal/VViki/Blog/Form (J/W/B/F)
	Search			4	Course Page (CP)
	Mail error			2	Form/Discussion/Chat (F/D/C)
	Mark read			2	Form/Discussion/Chat (F/D/C)
	Templates view			4	Course Page (CP)
		Course	View	4	Course Page (CP)
		Glossary	View	1	Journal/VViki/Blog/Form (J/W/B/F)
		Resource	View	4	Course Page (CP)
		Assignment	View	3	Submission/Report/Quiz/Feedback(S/R/Q/F
		Feedback	View	3	Submission/Report/Quiz/Feedback(S/R/Q/F
		User	View	4	Course Page (CP)

(continued)

Table 6.1 (continued)

FIS#	LMS Moodle metrics			Code#	FIS Input Name
	'Action'	Combination of 'Module' and 'Action'			
		'Module'	'Action'		
		Choice	View	3	Submission/Report/Quiz/Feedback(S/R/Q/F
		Wiki	View	1	Journal/VViki/Blog/Form (J/W/B/F)
		Lesson	View	1	Journal/VViki/Blog/Form (J/W/B/F)
		Blog	View	1	Journal/VViki/Blog/Form (J/W/B/F)
		Notes	View	1	Journal/VViki/Blog/Form (J/W/B/F)
		Quiz	View	3	Submission/Report/Quiz/Feedback(S/R/Q/F
		Scorm	View	3	Submission/Report/Quiz/Feedback(S/R/Q/F
		Data	View	4	Course Page (CP)
		Flashchat	View	2	Form/Discussion/Chat (F/D/C)
		Hotpot	View	3	Submission/Report/Quiz/Feedback(S/R/Q/F
		Chat	View	2	Form/Discussion/Chat (F/D/C)
		Journal	View	1	Journal/VViki/Blog/Form (J/W/B/F)
2	Add mod			5	Module (M)
	Add Post			6	Post/Activity (P/A)
	Add entry			7	Resource/Assign,ent (R/A)
	Add discussion			6	Post/Activity (P/A)
	Add comment			6	Post/Activity (P/A)
	Choose			6	Post/Activity (P/A)
	Choose again			6	Post/Activity (P/A)
	Start			5	Module (M)
	Start complete			5	Module (M)
	End			5	Module (M)
	Fields add			5	Module (M)

(continued)

Table 6.1 (continued)

FIS#	LMS Moodle metrics			Code#	FIS Input Name
	'Action'	Combination of 'Module' and 'Action'			
		'Module'	'Action'		
	Report			6	Post/Activity (P/A)
	Report live			6	Post/Activity (P/A)
	Report log			6	Post/Activity (P/A)
	Report outline			6	Post/Activity (P/A)
	Report participation			6	Post/Activity (P/A)
	Report stats			6	Post/Activity (P/A)
	Submit			6	Post/Activity (P/A)
	Subscribe			6	Post/Activity (P/A)
	Subscribe all			6	Post/Activity (P/A)
	Talk			6	Post/Activity (P/A)
	Attempt			6	Post/Activity (P/A)
	Continue attempt			6	Post/Activity (P/A)
	User report			6	Post/Activity (P/A)
	Bogus			6	Post/Activity (P/A)
	Set page flage			6	Post/Activity (P/A)
		Resource	Add	7	Resource/Assignment (R/A)
		Chat	Add	6	Post/Activity (P/A)
		Forum	Add	6	Post/Activity (P/A)
		Label	Add	8	Label (L)
		Assignment	Add	6	Post/Activity (P/A)
		Feedback	Add	6	Post/Activity (P/A)
		Choice	Add	6	Post/Activity (P/A)
		Calendar	Add	6	Post/Activity (P/A)

(continued)

Table 6.1 (continued)

FIS#	LMS Moodle metrics			Code#	FIS Input Name
	'Action'	Combination of 'Module' and 'Action'			
		'Module'	'Action'		
		Wiki	Add	6	Post/Activity (P/A)
		Glossary	Add	6	Post/Activity (P/A)
		Data	Add	5	Module (M)
		Lesson	Add	5	Module (M)
		Flashchat	Add	6	Post/Activity (P/A)
		Hotpot	Add	6	Post/Activity (P/A)
		Journal	Add	6	Post/Activity (P/A)
		Quiz	Add	6	Post/Activity (P/A)
		Scorm	Add	5	Module (M)
		Survey	Add	5	Module (M)
3	Assign			11	Assign (A)
	Unassign			12	Edit/Delete (E/D)
	Enrol			11	Assign (A)
	Unenrol			12	Edit/Delete (E/D)
	Unsubscribe			12	Edit/Delete (E/D)
	Upload			9	Upload (UP)
	Attachment			9	Upload (UP)
	Update			10	Update (U)
	Update comment			10	Update (U)
	Update entry			10	Update (U)
	Update feedback			10	Update (U)
	Update grades			10	Update (U)
	Update mod			10	Update (U)

(continued)

Table 6.1 (continued)

FIS#	LMS Moodle metrics			Code#	FIS Input Name
	'Action'	Combination of 'Module' and 'Action'			
		'Module'	'Action'		
	Update post			10	Update (U)
	Fields update			10	Update (U)
	Recent			10	Update (U)
	Move discussions			10	Update (U)
	Templates saved			9	Upload (UP)
	Edit			12	Edit/Delete (E/D)
	Edit section			12	Edit/Delete (E/D)
	Edit questions			12	Edit/Delete (E/D)
	Delete			12	Edit/Delete (E/D)
	Delete all			12	Edit/Delete (E/D)
	Delete attempt			12	Edit/Delete (E/D)
	Delete comment			12	Edit/Delete (E/D)
	Delete discussion			12	Edit/Delete (E/D)
	Delete entry			12	Edit/Delete (E/D)
	Delete mod			12	Edit/Delete (E/D)
	Delete post			12	Edit/Delete (E/D)
	Change password			12	Edit/Delete (E/D)
	Review			12	Edit/Delete (E/D)

values, respectively, are used for the FIS1–FIS4, whereas a five-level of trapezoid membership functions corresponding to Very Low (VL), Low (L), Medium (M), High (H) and Very High (VH) values are adopted for the final FIS5, increasing, this way, the resolution in the segmentation of the universe of discourse of the *AC*, *TP* and *ET* inputs and *QoI* output in the final FIS5 (Dias and Diniz 2013).

Figure 6.3 depicts an indicative example of the membership functions used in the linguistic inputs and output of the fuzzy systems FIS4 (left column) and FIS5 (right column). Moreover, for each FIS, a set of 120 IF/THEN fuzzy rules was defined, so to cover most of the possible combinations of the given inputs and output, accordingly, met in practice.

Figure 6.4 illustrates an excerpt of the IF/THEN fuzzy rules corresponding to the FIS5, defined through the Matlab software interface (2012b, The Mathworks, Inc., Natick, USA).

Finally, an indicative example, referring to the output surfaces of FIS4 (left column) and FIS5 (right column), is given in Fig. 6.5. The latter explains the

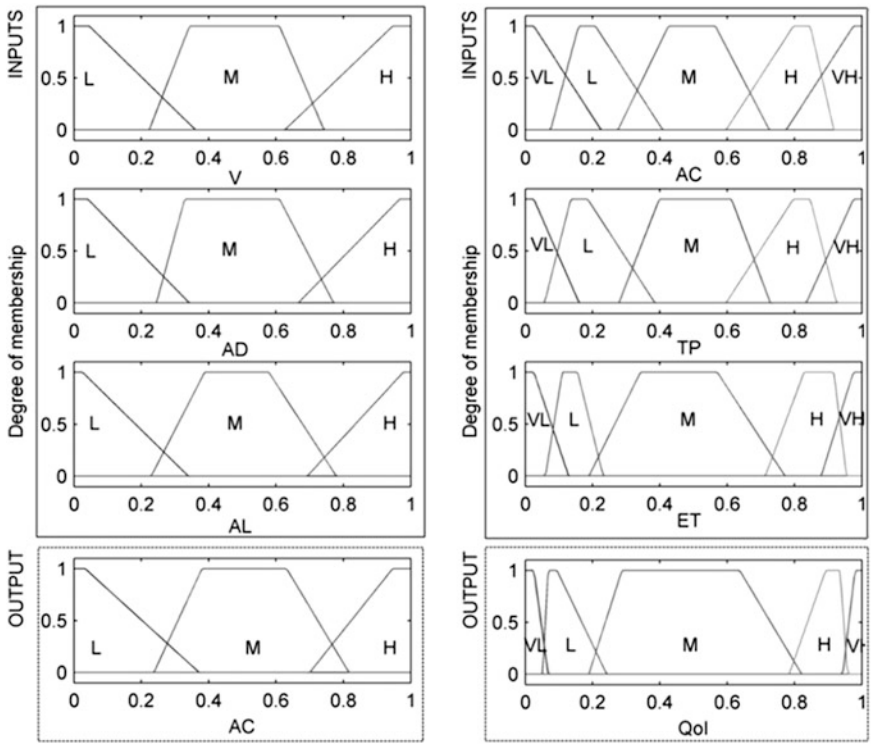

Fig. 6.3 An indicative example of the membership functions used in the linguistic inputs and output of the fuzzy systems FIS4 (*left column*) and FIS5 (*right column*); VL, L, M, H and VH correspond to Very Low, Low, Medium, High and Very High values, respectively; *V* View, *AD* Addition, *AL* Alteration, *AC* Action, *TP* Time Period, *ET* Engagement Time, *QoI* Quality of Interaction. (Dias and Diniz 2013)

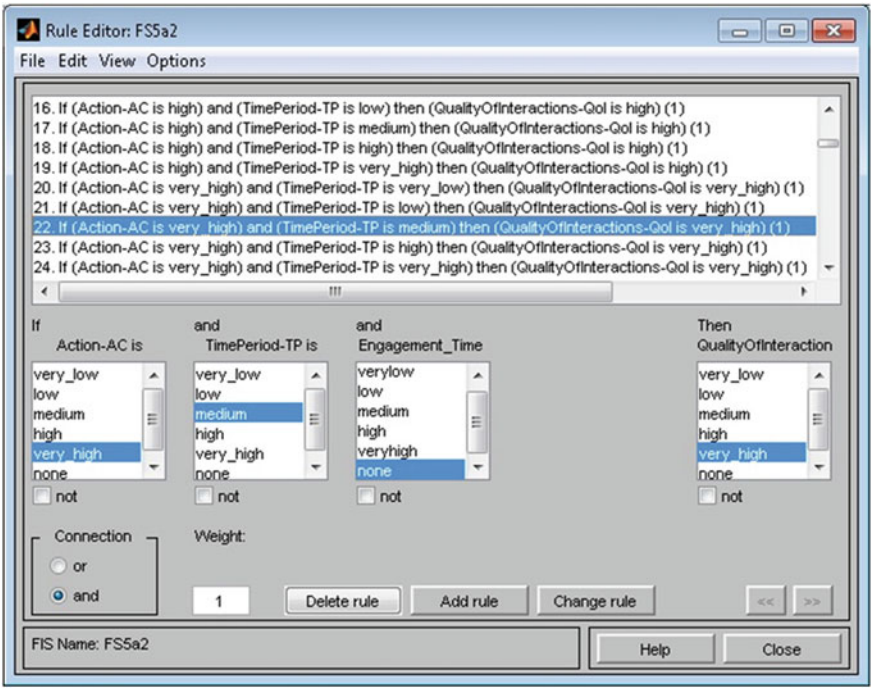

Fig. 6.4 An excerpt of the fuzzy rules corresponding to the FIS5, at the Matlab Fuzzy Toolbox interface (The Mathworks, Inc., Natick, USA). (Dias and Diniz 2013)

relationship among the inputs and output of the FISs used in the *FuzzyQoI* scheme, revealing a clear nonlinear relationship between the pairs of inputs and the corresponding output spanning the whole universe of discourse, for almost all cases. A lower degree of nonlinearity (compared to the other ones) is noticed in the combination of $\{(TP, ET) \rightarrow QoI\}$, especially for $(TP, ET) < 0.65$ (Fig. 6.5: right column-bottom). This means that *TP* and *ET* start to affect *QoI* when they exhibit quite significant values (closer to 1); otherwise, they converge *QoI* towards 0.5.

The use of a large number of variables (metrics) incorporated in the *FuzzyQoI* scheme for the evaluation of user's QoI increases the accuracy and validity of the intelligent system under consideration. Moreover, despite of the number of the variables employed, *FuzzyQoI* sustains its simplicity, as it is based on FISs in a cascade mode. As Dias and Diniz note (2013):

> The knowledge acquisition procedure for the development of each FIS knowledge base keeps its characteristics in tact; hence, the expert, by using a small number of variables, can easily describe the *FuzzyQoI* inference modules, i.e., the five FSs, which then produce a more complicated structure, yet beneficial to the quality of the final inference outcome (p. 43).

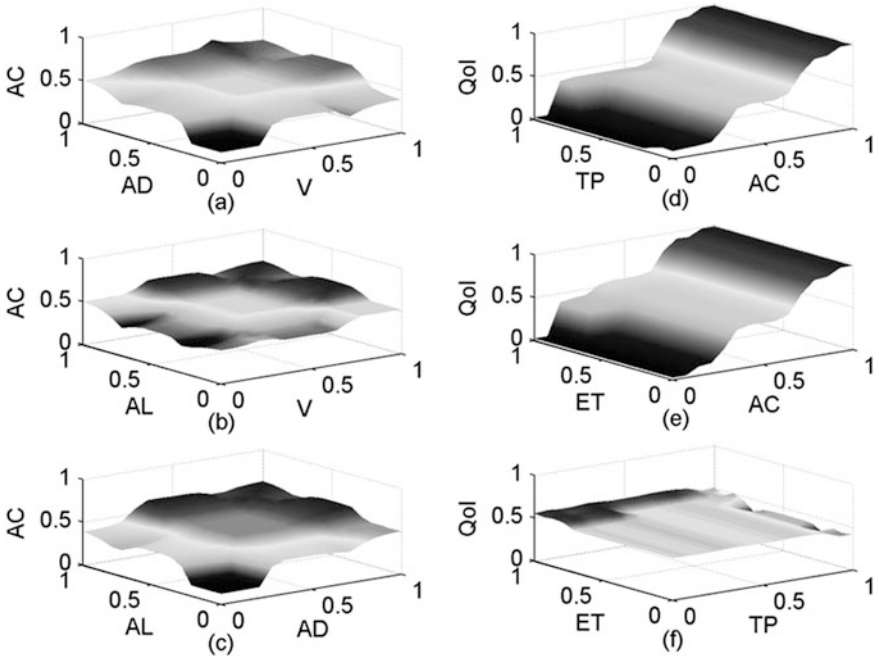

Fig. 6.5 Output surfaces for all combinations of inputs of the fuzzy systems FIS4 (*left column*, (**a**)–(**c**)) and FIS5 (*right column*, (**d**)–(**f**)); *V* View, *AD* Addition, *AL* Alteration, *AC* Action, *TP* Time Period, *ET* Engagement Time, *QoI* Quality of Interaction. (Dias and Diniz 2013)

The efficiency of the *FuzzyQoI* model is analytically discussed in the case study of Chap. 10, where it is applied to data drawn from a real-life LMS Moodle use, involving both professors and students.

6.6 Completing the Data Circle

The techniques discussed in this chapter complete the circle of data acquisition-data preparation-data analysis of Part II, establishing the necessary knowledge for the transition to Part III, where the theoretical concepts and models presented here are materialized to practical case studies.

Naturally, the current approaches do not totally cover all the issues that emerge through the data management in an OLE. They, however, span a range of approaches that are particularly useful for the efficient handling of the transactions data generated in the OLEs and contribute to the revelation of the underlying trends that govern behaviors and users' profiles. This becomes clearer through the bridging of theoretical concepts with practical implementations, as it is eminent from the case study paradigms that follow.

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Part III
The Art and Science of a Case Study in Higher Education: Towards a Pro-Intelligent System

Chapter 7
On Approaching Usability Issues in an OLE

7.1 Introduction

The terms of *art* and *science* referred to the title of this third part reflect the coexistence, integration and harmony of seemingly opposing extremes: the particular and the general, subjectivity and objectivity, the individual and the social context. By adopting this perspective, and by using the knowledge from the previous parts, different users' opinions, profiles and attitudes within an OLE are explored in this part through the description of a series of four case studies applied in a public HEI, corresponding to Chaps. 7–10, respectively. Through this practical evaluation of the methodologies deployed in previous chapters, current and novel trends, along with current and future modeling perspectives in b-learning environment are identified. Furthermore, some key opportunities for the development of intelligent LMS (*i*LMS), its implications for learning and teaching, as well as usability, quality, and accessibility issues are critically discussed.

This chapter focusses on the usability issues that appear in an OLE and tries to approach them from various perspectives, targeting issues like OLE access, effectiveness, learning, social networking, and information exchange. Before deeping into the latter, however, it is useful to examine the more general environment that hosts an OLE.

Inevitably, the ICTs are changing the world; they have changed ways of thinking, understanding, expressing and appreciating. HEIs cannot be indifferent to the "novel" way of understanding the world, in order to adopt flexible and enriched teaching–learning approaches. In fact, from multiple ways, technological revolution has influenced the current formal education revealing a transition from the Information Society to the Society of Knowledge and Learning; however, according to Duchateâu (1996): "pedagogical technologies are introduced without really changing the entire school" (p.1). From this perspective, HEIs need to discover their transformative potential, adopting new working styles, and promoting concepts like *produsage*, to emphasize certain skills/attitudes (e.g., creativity, collaboration, communication) and to engage learners in higher order thinking (see Sect. 2.2.1). Actually, the emergence of technological innovations,

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particularly digital technologies, over the last half century has had a huge impact on the possibilities for learning in the distributed environment.

Currently, there is a trend towards the use of blended solutions that combine classroom education and distance learning (Osguthorpe and Graham 2003; Garrison and Kanuka 2004; Bonk et al. 2005). From a concrete point of view, blending can occur in four different levels (Bonk and Graham 2006):

- activity level;
- course level;
- program level; and
- institutional level.

Across all aforementioned levels, the nature of the blends is either determined by the learner or the designer/instructor. Fortunately, e/b-learning modalities can be seen as opportunities for students to enhance learning and to develop the essential ICT skills necessary for self-directed learning. From this perspective, an OLE that allows users to co-construct individual and collective tasks, structured upon problem-based learning approaches, should be endorsed, in order to promote learner's flexibility, autonomy, creativity, as well as to stimulate learner-context collaboration and interaction. For instance, Salmon's e-moderating model (Salmon 2000), underlines a number of processes that are vital for the effective use of e-learning. In fact, Salmon's model suggests the design of a wide variety of online activities in five-stage, namely: (1) access and motivation, (2) online socialization, (3) information exchange, (4) knowledge construction, and (5) development (Salmon 2000). These stages are mostly related to the creation of *right* conditions to support students' self-confidence in managing their own learning, through encouraging interaction between students and the e-moderator. It is suggested that learners' online interactions foster a sense of belonging in the academic community, promote information sharing, critical reflection, and independent learning (see also Sect. 1.2.1). Complementary, it is important to underline that teachers should integrate ICTs in their teaching (Mishra and Koehler 2006), yet driven by the collaborative work with a team of experts focused on pedagogical, accessibility and usability issues.

7.1.1 Usability Issues

The usability analysis of information systems has been the target of several research studies over the past 30 years, highlighting a great diversity of perspectives from different fields (e.g., ergonomics, computer science, design, and education). In fact, the usability concept seen as a *fuzzy feeling of user-friendliness* (Shackel 1991) incorporates multiple components and it is directly associated with five mainly qualities (Nielsen 1993), i.e.:

- *learnability:* the system should be easy to learn;
- *efficiency:* the system should be efficient to use;
- *memorability:* the system should be easy to remember;
- *errors:* the system should be have a low error rate; and
- *satisfaction:* the system should be pleasant to use.

At the same time, according to ISO/IEC 9126 (2013), for evaluative purposes of software, usability must include four main features, namely: understandability, learnability, operability, and attractiveness. In other words, the usability of a LMS is considered an important condition for providing an effective and user-friendly learning environment. For instance, the LMS Moodle interface in its standard form provides the following features:

- authoring tools for content creation, inclusion and organization;
- users, roles and permissions management;
- student and course evaluation;
- interaction, communication and collaboration amongst users.

In this sense, to decide which tools must be used in an OLE, their particular advantages and limitations have to be considered. Learning Web 2.0 environments should be fitted to the specific needs of the users, in terms of functionality and usability (Redecker et al. 2009).

In general, the methods used to evaluate the usability in OLEs are the same ones used for general systems (i.e., non-educational) through checklists, heuristics evaluations and norm inspections, in order to discover if the system fulfills or not the minimum conditions to function without creating limitations (Freire et al. 2012). Despite this, Shackel (1991) considers that the multidimensional nature of usability includes the following parameters:

- efficiency,
- learning,
- flexibility; and
- the user's attitude.

Concerning the methods engaged towards user's performance, *adaptations* of consolidated evaluation methods have been considered, e.g., usability tests using semi-structured questionnaires and interviews. Additionally, multidisciplinary evaluations can also be considered, where a blend/mix of methods, techniques and methodologies is more oriented to the educational and socio-cultural aspects of the system (i.e., socio-cultural profiles of users) (Freire et al. 2012).

In this vein, the case study that follows aims to exemplify the communication tools used in a particular OLE and the way these online resources can contribute to the development/improvement of instructional practices.

7.2 Case Study Structure

7.2.1 Data Acquisition/Preparation

Adopting the methodology presented in Part II (Chaps. 4–6), the current case study was structured upon a series of steps. In particular, for the characterization of the context under consideration, a documental analysis for the collection of information electronically available from the LMS initially took place. To this end, qualitative indicators concerning, the type of *activities*, *structure* and the *contents* of all available disciplines in the LMS were defined. In addition, some statistical analysis reports created from LMS Moodle, regarding the "users' LMS access" and "LMS activity type", were extracted.

The data sample involved those teachers of the Department of Sciences Education (DSE) of the FHK that actively used the LMS Moodle; then, semi-structured interviews were conducted and validated. The use of the semi-structured interviews had four main objectives:

- to characterize the LMS Moodle platform within the context of particular disciplines;
- to characterize the role of the teacher in the OLE;
- to characterize the role of the student in the OLE; and
- to promote the discussion of future constraints/potential of the LMS Moodle.

The 50-min interviews were, individually, performed at the DSE from July to September of the academic year 2008/2009. The specific interaction period was enriched with e-mail, phone communication and direct contact with participants, with all interview data being digitally archived.

Moreover, students were also involved in the case study through an online survey. In the latter, the following hypotheses were considered:

- H1: the use of more innovative communication tools depends on the facility to use the LMS Moodle platform;
- H2: the satisfaction level of students concerning their use of the LMS Moodle platform is related to their autonomy to develop their work; and
- H3: the efficiency of the LMS Moodle platform depends on the teacher's performance as moderator, particularly regarding the quality and effectiveness of the information shared with the students.

The online survey was initially applied to 10 students of different courses of the FHK, seeking to ensure its applicability and appropriateness. From the analysis of the responses, some ambiguities in statements were identified and rectified a posteriori. The final version of the survey was posted online,[1] being available

[1] Online test-version available from: http://inqueritos.fmh.utl.pt/index.php?lang=pt&sid=35883&token = v6cvw4ew3ycqbw2.

between July and September 2009, and the students were informed about the access site of the survey via e-mail, requesting their participation. At final, five teachers (40 % female and 60 % male, aged between 29–60yrs old) and 104 students (48.1 % female and 51.9 % male, aged between 18–35yrs old) of the FHK were involved in this empirical/descriptive case study.

In summary, the online survey and the interview were organized in four main sections:

- Section 1: examination of some usability issues in the OLE;
- Section 2: characterization of the communication tools available in the OLE;
- Section 3: characterization of the teachers' role in the OLE; and
- Section 4: characterization of the students' role in the OLE.

7.2.2 Data Analysis

At the beginning, some data directly drawn from LMS Moodle were analyzed using graphical representations (e.g., access, activity, view, contribution), as well as some statistical reports, automatically performed by the LMS Moodle. Then, the data collected in the interviews were analyzed using the content analysis software MAXQDA 2007 (see Sect. 6.4.1.). To this end, five protocols were obtained through the interview transcriptions (Teacher#1–Teacher#5).

Finally, the data collected through the online questionnaire were analyzed using the software LimeSurvey and then handled using Microsoft Excel. Additionally, an inferential statistical analysis was performed using the software SPSS 18.0. In order to test the aforementioned hypotheses H1–H3, contingency tables (crosstabs) and Chi square (χ^2) test of independence were conducted (Sect. 6.3.1.). Being a non-parametric statistical test, χ^2 was adopted to investigate the existence of an association between two categorical/nominal types of variables (Gray and Kinnear 2012). From this perspective, the statistical significance of associations was verified from the application of χ^2 test of independence, with *Yates' correction* (Calder 1996), to the contingency tables of cases H1–H3, adopting a significance level of 0.05; hence, $p < 0.05$.

7.3 Case Study Results

7.3.1 General Perspective

From the documental analysis referring to the context understanding, some statistical reports concerning the *access* and *activity* of the total number of LMS Moodle users (1,374 in the context of 47 disciplines) were derived (see Fig. 7.1).

From Fig. 7.1a, an average LMS access rate of 360 records can be identified, with 2,907 logins per month in average, being especially high in the periods of

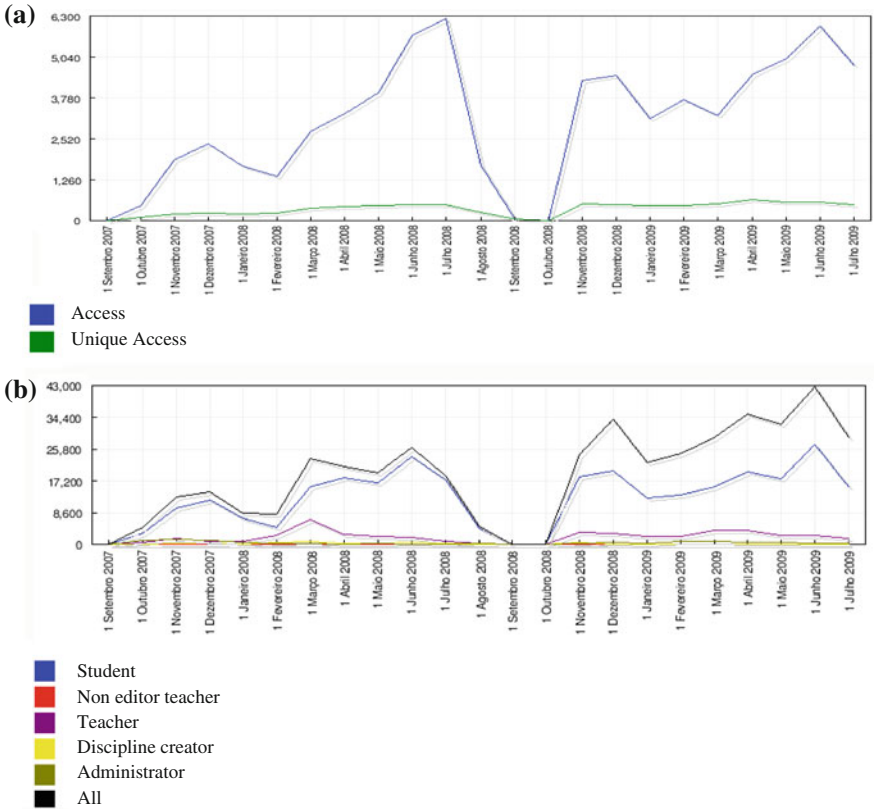

Fig. 7.1 Graphical representation of the **a** *access* and **b** *activity* from September 2007 until July 2009 of the 1374 LMS Moodle users in the context of 47 disciplines

June 2008 (i.e., 6,230 logins) and May 2009 (i.e., 5,987 logins), compared to the other months. Moreover, from Fig. 7.1b, an increase in the LMS Moodle activity rate in the period of two years, i.e., 2007–2009, can be noticed, reaching a maximum peak during the period of June 2009 (i.e., 42,848 logins, corresponding to 38-visitor, 27,044-student, 2,436-teacher, and 241-administrator). Actually, these results can be explained by the fact that June corresponds to the final period of evaluations (in general), and as an ordinary consequence, the users' access to the materials/contents tend to be more notorious in this specific period.

In addition, during each September (both in 2007 and 2008), very few access and activity data were identified, coinciding with the holiday period of the FHK. From the comparison between teachers and students, Fig. 7.1b reveals higher activity in the LMS Moodle from the students (blue line) compared to the teachers (magenta line).

Table 7.1 Communication tools/activities used in LMS Moodle (academic year 2007/2008)

Tools/Activities	N
Forum	21
Daily	5
Chat	4
Glossary	6
Resource	41
Referendum	1
Test/survey	6
Work submission	12
Wiki	2
SCORM	1
Total	99

Furthermore, the use of communication tools/activities in LMS Moodle data was also examined, with the frequency N of use per tool/activity being tabulated in Table 7.1.

When looking at Table 7.1, it is clear that two types of tools, i.e., *Resource* (N = 41) and *Forum* (N = 21), were mainly used in LMS Moodle. However, in the opposite direction, *Referendum* (N = 1), *SCORM* (N = 1) and *Wiki* (N = 2) can be identified with the lowest-frequency of use.

In a complementary perspective, the frequency N of the three qualitative indicators (i.e., *Activities, Structure* and *Contents*) of all available disciplines in the LMS is depicted in Table 7.2. From the latter, concerning the *Activities* category, it is clear that the most available disciplines in LMS Moodle (N = 18, 38 %) have incorporated different activities (e.g., chat, discussion, wiki, quiz); however 25 % (N = 12) of the disciplines have not offered any activities/documents.

Furthermore, analyzing the *Structure* category, from Table 7.2 it is understandable that the most available disciplines in LMS Moodle follow an organized structure (49 %); however, 43 % of the disciplines have serious troubles in file location or are simply unnamed (Table 7.2). In addition, from the category *Content*, it is clear that all available disciplines in LMS Moodle have presented some kind of content (i.e., 0 % of disciplines are identified without content). Moreover, 49 % of the 47 disciplines analyzed in LMS Moodle have integrated interactive contents, such as links, audiovisual elements, and multimedia/evaluation resources (Table 7.2).

The above results provide a general perspective of the participation, activity, structural and contextual characteristics of the LMS Moodle during its interaction by the users (e.g., teachers and students).

Table 7.2 The systematization/analysis of three qualitative indicators of all available disciplines in LMS Moodle (academic year 2007/2008)

Category	Subcategory	Description	N	(%)
Activities	Activity 0	Without activities/documents	12	25
	Activity 1	Uses at least 1 activity	4	9
	Activity 2	Slides, resources, docs, modules	13	28
	Activity 3	Chat, discussion, wiki, quiz, SCORM[a]	18	38
		total	47	100
Structure	Structuring 1	Unnamed, trouble finding files	20	43
	Structuring 2	Module's structure - blank, no organization criteria	4	8
	Structuring 3	Organized	23	49
		total	47	100
Content	Without content	Without content	0	0
	Content A	The content has no negative aspects	4	8
	Content B	Content has at least one positive aspect	6	13
	Content C	Links, audiovisual elements, multimedia/ animations	23	49
		total	47	100

[a] Here, the SCORM module is considered a course activity (http://docs.Moodle.org/en/SCORM)

7.3.2 Some Usability Issues

Moving on to the results from the analysis of data collected through the interview (teachers' opinion) and the survey (students' opinion), an examination of some usability issues in the OLE (Section 1) was carried out in terms of learnability, effectiveness, flexibility and user satisfaction for teachers (see Table 7.3) and students (see Fig. 7.2).

From the Teachers' perspective (Table 7.3), *Effectiveness* was the subcategory that exhibited the highest value of TU (TU = 18, ~35 %) of a total of 51 TUs codified. In fact, one interviewee (Teacher#5) notes that the OLE is:

> …fairly simple, super affordable, accessible, intuitive, and students are already familiar with ICT. The LMS Moodle provides an easy and accessible solution, i.e., it is simple to navigate and has an intuitive interface. It isn't difficult to understand, in general.

Interestingly, from the Students' perspective (Fig. 7.2), the *Effectiveness* was also more emphasized than the other subcategories (~71 %). These results

Table 7.3 Frequency N (in terms of text units-TU) of the usability issues in the OLE according to the opinion of the teachers interviewed

Usability Issue	N (TU)	(%)
Learnability	14	27.5
Effectiveness	18	35.3
Flexibility	7	13.7
User satisfaction	12	23.5
Total	51	100

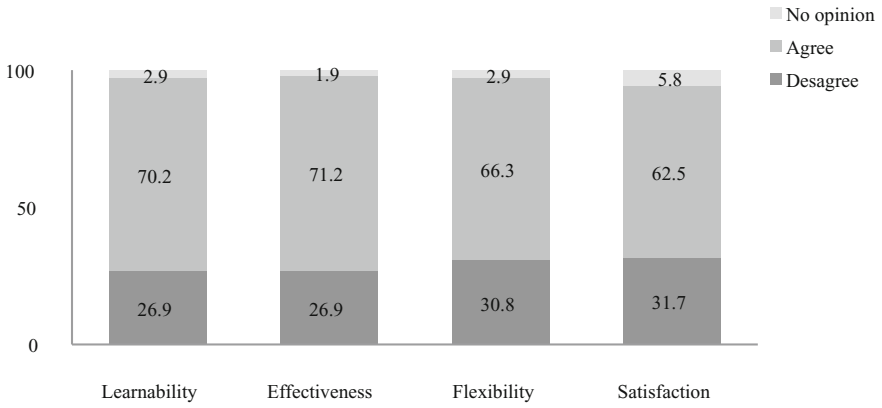

Fig. 7.2 The distribution of usability issues identified in the OLE according to the students' opinion participated in the online survey

provide a sense of the usability issues acknowledged by the teachers and students in the LMS Moodle and the way they have categorized them, accordingly.

7.3.3 Characterization of the Communication Tools

Characterization of the communication tools available in the OLE (Section 2) has also been considered, focusing mainly at six different levels, i.e.: (i) access to learning material, (ii) social networks, (iii) digital skills and innovation, (iv) personal achievement, (v) personal and learning skills, and (vi) metaskills. The results from this approach for the teachers and students are tabulated in Table 7.4 and depicted in Fig. 7.3, respectively. From Table 7.4 it is clear that 83 TUs in total were classified and the subcategory *Personal and learning skills* exhibited the highest value of TUs codified (TU = 23, ~28 %).

These results are supported by the perspective of a Teacher (Teacher#4) stating:

Table 7.4 Frequency N (in terms of text units-TU) of the communication tools in the OLE according to the opinion of the teachers interviewed

Communication Tool	N (TU)	(%)
Access to learning material	11	13.2
Social networks	6	7.2
Digital skills and innovation	13	15.7
Personal achievement	17	20.5
Personal and learning skills	23	27.7
Metaskills	13	15.7
Total	83	100

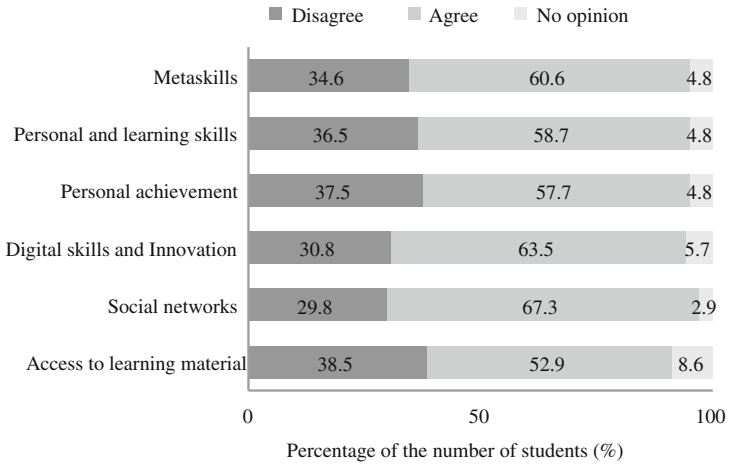

Fig. 7.3 The distribution of communication tools in the OLE characterized by the students participated in the online survey

> Those teachers that already manage the LMS Moodle in an easy way tend to continue improving its use and/or developing their own personal ICT skills; however those teachers, who are not capable to do it, are usually forced to use the Moodle for evaluation issues.

In general, from the students' point of view, there is a remarkable agreement in the value given to all subcategories (see Fig. 7.3); however, the subcategories *Social networks* (~67 %) and *Digital skills and innovation* (~64 %) received higher ranking in comparison to the others.

Focusing to the type of communication tools used, the subcategory most valued by the teachers was *Asynchronous* (TU = 16, ~84 %), as indicated in Table 7.5. Teacher#1 also supports this point of view when he states:

> I did not use the real time tools (i.e., synchronous tools) during classroom instruction. I mainly use the others (i.e., asynchronous). In fact, I can say that for my personal use the OLE have served about 90 % as a repository of contents and information.

The corresponding results for the case of students are depicted in Fig. 7.4. From the latter, it is clear that the types of communication tools most used by students were (in a descending order): *news* (~63 %), *email* (~60 %), and *glossary*

Table 7.5 Frequency N (in terms of text units-TU) of the type of communication tools in the OLE according to the opinion of the teachers interviewed

	N (TU)	(%)
Asynchronous	16	84.2
Synchronous	3	15.8
Total	19	100

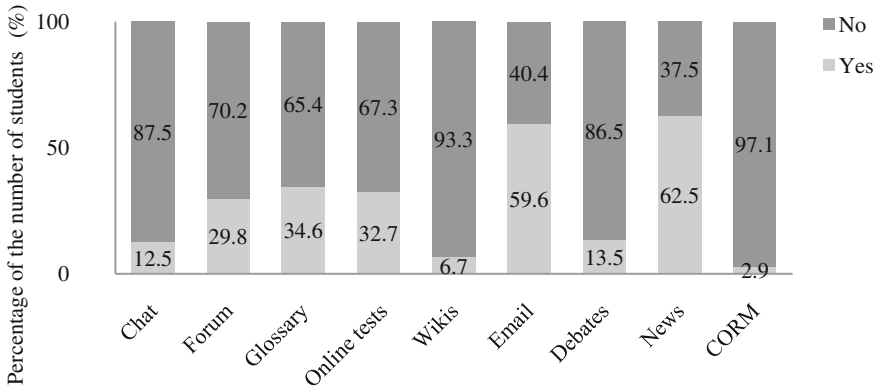

Fig. 7.4 The distribution of the type of communication tools in the OLE characterized by the students participated in the online survey

(~35 %), i.e., asynchronous tools. Inversely, the *chat* (~13 %), *wiki* (~7 %), and *SCORM* (~3 %) clearly presented lower frequency of use.

The abovementioned outcomes show the preferences of the LMS Moodle users regarding the types of communication tools considered most useful to accomplish successful interaction with the OLE.

7.3.4 Characterization of the Teachers' Role

The results from the characterization of the teachers' role in the OLE (Section 3), based on five distinct stages, i.e.: (i) access and motivation, (ii) online socialization, (iii) sharing information, (iv) knowledge construction, and (v) reflective and creative development, are presented in Table 7.6, for the case of the teachers, and in Fig. 7.5, for the case of students. From the total of 78 TUs codified, it is clear that the *Online socialization* (TU = 20, ~26 %) and *Sharing information* (TU = 20, ~26 %) subcategories were the most valued by teachers, as it is

Table 7.6 Frequency N (in terms of text units-TU) of the teachers' role in the OLE according to the opinion of the teachers interviewed

Teachers' Role	N (TU)	(%)
Access and motivation	9	11.5
Online socialization	20	25.6
Sharing information	20	25.6
Knowledge construction	16	20.5
Reflective and creative development	13	16.7
Total	78	100

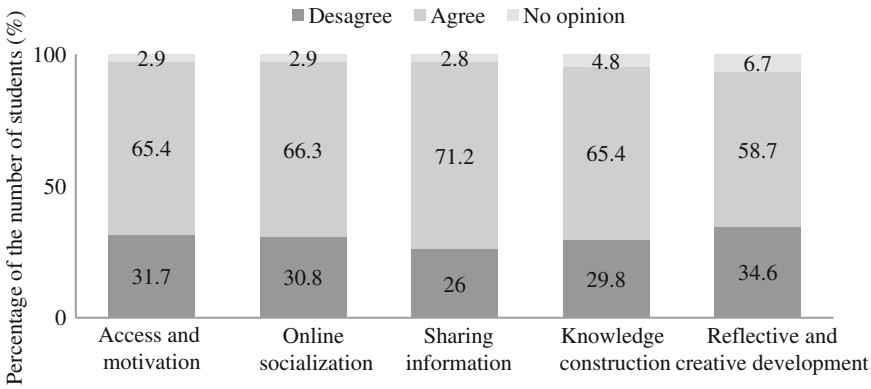

Fig. 7.5 The distribution of the teacher's role in the OLE characterized by the students participated in the online survey

derived from Table 7.6. Teacher#5 reinforces these results, when reports the following perspective:

> For instance, the discussion forum is an amazing tool that can really help students in different ways, e.g., to develop social skills, to promote a cooperative and collaborative learning environment, promoting their social interaction. Everyone can easily participate and give their opinion, contributing, in general, to an open sharing atmosphere.

Similarly to the teachers' opinion, the subcategories *Sharing information* and *Online socialization* were those that revealed the highest values (~71 and ~66 %, respectively), for the case of students (see Fig. 7.5).

The results of this analysis show that there is a bilateral agreement upon the teachers' role in the LMS Moodle, with both stakeholders (teachers and students) agreeing on the reinforcement of the social character of teacher's mediation to the learning process by promoting knowledge sharing within an OLE.

7.3.5 Characterization of the Students' Role

The results from a meticulous characterization, based on particular skills (i.e., creativity, collaboration, critical capacity, communication and autonomy), as a means to better understand the students' role in the OLE (Section 4) are presented in Table 7.7, for the teachers' case, and in Fig. 7.6, for the students' case. From Table 7.7, it is deduced that the subcategory *Autonomy* (TU = 6, 25 %) was the dimension most valued by the teachers (24 TU in total).

In this context, the use of the LMS Moodle seems to facilitate the development of independent work, as reported by Teacher#2:

Table 7.7 Frequency N (in terms of text units-TU) of the students' role in the OLE according to the opinion of the teachers interviewed

Students' Role	N (TU)	(%)
Creativity	5	20.8
Collaboration	5	20.8
Critical capacity	5	20.8
Communication	3	12.5
Autonomy	6	25.0
Total	24	100

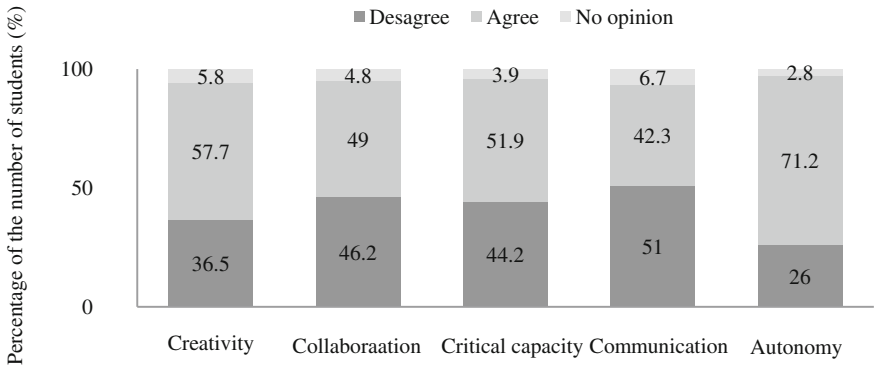

Fig. 7.6 The distribution of the students' role in the OLE characterized by the students participated in the online survey

> Initially, all students want to participate and collaborate in Moodle environment. Students, in general, are very autonomous and, actually, are never obligated to participate. They have a lot of work in other disciplines… Sometimes I organize different groups of students and they have to assign some works using the Moodle. It is a great solution to add online comments and formative feedback.

Engagingly, as it is deduced from the Fig. 7.6, the subcategory *Autonomy* was also the dimension most valued by students (~71 %), followed by the subcategories *Creativity* (~58 %), and *Critical capacity* (~52 %).

Apparently, the aforementioned results reveal the autonomy trend that both teachers and students appreciate for the interaction of the latter within the LMS Moodle, yet combined with the potential of the OLE to increase critical thinking and creativity during online learning.

7.3.6 Inferential Perspective

As described in Sect. 7.2.2, all descriptive analysis was complemented by a relational analysis between variables considered in the online questionnaire.

Table 7.8 Values of statistical significance for each Hypothesis obtained through the Chi square (χ^2) test of independence, with *df* degrees of freedom and *p* probability of false alarm

Hypothesis 1 (H1)	$\chi^2 = 31.734$, $df = 1$, $p < 0.001$
Hypothesis 2 (H2)	$\chi^2 = 29.270$, $df = 1$, $p < 0.001$
Hypothesis 3 (H3)	$\chi^2 = 44.306$, $df = 1$, $p < 0.001$

The results confirmed the three aforementioned study hypotheses (H1–H3, see Sect. 7.2.2); more specifically (see Table 7.8):

- H1: there are a significant relationship between innovation in the context of communication tools' use and the facility to use the LMS Moodle;
- H2: the satisfaction level of the students in using the LMS Moodle are associated to their autonomous capacity of work; and
- H3: the efficiency of the LMS Moodle is related to teachers' role in the LMS Moodle, especially concerning the effectiveness and quality of the information shared with students.

7.4 Final Considerations

The case study presented in this chapter was, actually a pilot/feasibility study, which is a small investigation, essentially designed to test instruments/methodologies, such as a questionnaire or interview, and simultaneously to gather previous information, in order to improve the quality and efficiency of a more powerful study (van Teijlingen and Hundley 2001). In September 2007, after the implementation of the LMS Moodle in the FHK, it was recognized the need to embrace b-learning solutions as important future directions to improve faculty development initiatives, in general, and instructional practices, in particular. One of the advantages of developing this case study is that it can give advance warning with regard to the limitations of the extended investigation (e.g., whether considered methods/instruments are appropriate or too complicated; whether proposed questions are redundant) (Cochran and Cox 1992; Lancaster et al. 2004). Moreover, although a preliminary study usually tends to reveal some weaknesses in the design or procedure used, it should essentially provide vital/precious information and good research strategies to potentiate future investigations.

From a general perspective of the results derived from this case study, in terms of users' *Access* in the LMS Moodle, a gradual evolution during the two years analyzed was identified, reaching more notorious expression in the months of the final evaluations (e.g., June), compared with the other months. In addition, the results generally demonstrated that most of teachers have used in their disciplines different kind of *Activities*, such as resources, discussion forums, chats, glossaries, quiz and wiki; however, only a few of them tended to stimulate collaborative,

synchronous and interactive work/activities in an integrated way. In fact, a recent study has concluded that the chat and wiki tools reveal some difficulties of use (Muniz and Moraes 2012).

Regarding the LMS *Usability* issues, it seems fair to say that the LMS Moodle was considered by the users as an intuitive navigation system, especially in terms of *Effectiveness*, i.e., the easiness of using the OLE. Actually, according to Davis et al. (1989), the perceived ease of use refers to the degree to which a person believes that using a particular system would be free of effort.

In addition, the results seem to show that the LMS Moodle can be seen as an important contribution to enable the development of *Personal and learning skills* and *Social networks*, in general.

Furthermore, a combination of synchronous/asynchronous tools can provide an environment rich in various opportunities for interaction, allowing people to collaborate in distributed environments (Dede 1996). In any case, the LMS Moodle was mainly used as a repository of information, supported fundamentally by *Asynchronous* tools (e.g., email, news, glossaries). Likewise, Bates (1995) has categorized interaction according to the time of interaction and context for interaction (i.e., synchronous *versus* asynchronous, and personal *versus* social interaction), arguing that different educational objectives and needs require different types of interaction.

Regarding the level of teacher's role/intervention in the OLE, the results revealed that the LMS Moodle lies essentially in the stage of *Online socialization* (i.e., construction of learning community) and *Information exchange*. In fact, the teacher at *Information exchange* stage appears as an e-moderator, creating activities (e.g., discussion forums, online discussions) that enable effective information sharing amongst all stakeholders of the learning community (Salmon 2000). From this perspective, perhaps, *Knowledge Construction* and *Development* stages should be recommended for future directions/advances of this HEI.

A major aim in HEIs is to produce independent (or autonomous) learners (Franklin and van Harmelen 2007) and, accordingly, the learning tools should be based on independent learning (e.g., tutorials, virtual labs, e-books) (Anderson 2004). In fact, this case study highlighted that concerning the students' role in the OLE, the *Autonomy* dimension plays an important role in online environments. However, getting the right blend between opportunities for synchronous and asynchronous interaction and group and independent study activities still remains a true challenge.

Finally, from the *inferential analysis*, the results supported a significant relationship between: innovation and facility to use the LMS Moodle (H1, $p < 0.001$); students' satisfaction and autonomous work (H2, $p < 0.001$); and LMS efficiency and teachers' role in the LMS Moodle (H3, $p < 0.001$).

These findings indicate the importance of the characteristics of the users to be interwoven in the OLE in a creative way that blends human needs with technological responses and potentialities.

7.5 Overview

The growing adoption of LMS, in particular the Moodle platform, has led to the introduction of new teaching/learning approaches and to the promotion of different educational contexts within the online environment. The descriptive case study presented in this chapter explored the significance of the relationship between innovation regarding the use of communication tools and the easiness to use the LMS Moodle; the satisfaction level of the students in using the LMS when it is associated to their autonomy; the dependence of the efficiency of the LMS Moodle upon the teacher's role in the platform, namely in what concerns the effectiveness and quality of the information shared with the students.

Overall, the results showed that the use of a LMS Moodle may represent an important resource for the achievement of personal goals, by encouraging collaborative work and personalized learning. Nonetheless, it is essential to encourage the dissemination, training and expertise, in order to enable the improvement of the teaching/learning process based on collaborative processes. In this endeavor, important role plays the understating of the profile of the two active participants, i.e., teachers and students, within an OLE adopting the b-learning context. The latter sets the core thematology analyzed and discussed through the case studies of the two chapters that follow.

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Chapter 8
Rethinking Blended Instruction: Academic Community and Teachers' Profiles

8.1 Introduction

The impact of globalization and cultural pluralism from the combined perspectives of the new dimensions of e-community and e-identity (Wenger 1998; Zhou 2011) may justify innovative methodologies in the design, implementation and development of the teaching-learning process. It is important, however, to realize that "cultural differences play a large role in how distance learners from different parts of the world interact with teaching and learning" (Simonson and Crawford 2005, pp. 95–96).

In a b-learning environment, the educational process may respond to new working styles to promote specific skills and attitudes, such as creativity, collaboration, communication, critical capacity and independent learning (Redecker et al. 2009). In this scenario, both social-cultural trends and open innovation challenges (e.g., social software, mobile learning, and open source software/content) seem to affect learning in a knowledge-based society (Punie and Cabrera 2005).

Indeed, emerging technologies allow both students to learn (on their own or in informal collaboration with others)—anytime and anywhere—and HEI to focus on global learning environments—synchronous and asynchronous—if adequately used (Beldarrain 2006). The reorganization of teaching-learning dynamics through phenomena, such as group interaction, collaboration, higher-order thinking and teamwork, seems to require the establishment of complex roles in the process of (lifelong) learning and knowledge building. In agreement with Bonk and Reynolds (1997) "With WBI [Web-Based Instruction] students now have new learning partners and learning materials for discovering, producing, and synthesizing knowledge" (pp. 174–75).

In distance online education, the motivational effect of charismatic and collective leadership might also represent an important issue (Bates and Sangrà 2011). According to Prensky (2009) "It's time for education leaders to raise their heads above the daily grind and observe the new landscape that's emerging" (p. 306). Unfortunately, the creation of an online community of practice is not

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always accompanied by a similar passion to improve the quality of e-teaching. From this perspective, Wenger et al. (2002) argue that "A community of practice (*CoP*) is not like a team that management can assemble unilaterally; its success depends too much on personal passion for coercion to be effective." (p. 36). In turn, the conditions related to successful technology integration appears to require both human effort, resilience and a systemic engagement by all of the (multi) stakeholders involved. Furthermore, even though there is an increasing awareness of teachers as to the value of training on ICT usage, relatively few teachers are able to integrate ICT into their teaching activities (Dawes 1999). Additionally, the lack of faculty motivation to integrate technology in online courses is considered the most important challenge for the successful implementation of blended teaching/learning practices (Oh and Park 2009). Some studies have also revealed that the faculty members need more time to expand their experience in technology-based instruction, e.g., e-moderation (Salmon 2000) and/or technology integration (Mishra and Koehler 2006), with the purpose of improving their technological and methodological knowledge for their own and for their students (Howell et al. 2004). Indeed, external barriers (e.g., access, training, local support) and internal barriers (e.g., teacher's beliefs, teacher's self–efficacy, teacher's attitudes) were considered as important obstacles that influence the teachers' ICT implementation efforts (Ertmer 1999). In addition, both cultural identities and thinking processes have also been identified as relevant barriers to ICT integration in the educational process (Watson 2001).

Moreover, teachers with a strong sense of self-efficacy and more receptive to innovative ideas/strategies have also been associated to teachers with an attitude toward efficacy on computer usage (Compeau and Higgins 1995). There is also evidence that the integration of non-linear, multi-sensorial, and multimodal interactive systems tend to offer strong potential to expand learning opportunities (McGuire 1996). Furthermore, technology knowledge in blended communities tends to be an emerging need, requiring "a new set of skills for most educators and learners" (Simonson 2005, p. 284). Some researchers (Redecker et al. 2009; Watson 2006) have also stressed that the use of ICT for teaching purposes is considered a powerful motivating issue for pedagogical/instructional innovation.

Stemming from the abovementioned, the case study of this chapter aims at both understanding teachers' needs and identifying their profiles at a HEI, in order to empower the quality of distance education, in general, and b-learning, in particular. Overall, this case study addresses the following research questions:

- Are teachers satisfied with b-learning course?
- How do they perceive a b-learning environment?
- What instructional tools/strategies are used in the LMS?

In other words, this case study characterizes the main landscape processes (or fluxes) of the CMS (supported by LMS Moodle) from the viewpoint of the teachers of a public HEI.

8.2 Case Study Structure

8.2.1 Participants

In order to deeply understand the LMS Moodle usage, the subjective standpoint of the teachers of five undergraduate courses offered by a public HEI (i.e., FHK) was analyzed. In fact, 32 teachers (50 % female), with ages ranging from 24 to 54 yrs old (M = 43.19, SD = 8.01) were involved in this case study. Most teachers (N = 19, 59 %) started to use the LMS in 2009/2010 academic year and 69 % (N = 22) made their first access in September 2009. To this end, all participants used b-learning via LMS Moodle for at least six months. Moreover, the participants were categorized into two groups according to the frequency of LMS Moodle usage, i.e., most active teachers (50 %, N = 16) and the less active teachers (50 %, N = 16).

8.2.2 Instruments for Data Collection and Analysis

The participants were subjected to interview and data were collected in the first semester of 2010/2011 academic year. Each interview was audio-recorded with the participants' agreement and transcribed verbatim. Consequently, 32 protocols were performed through the interview transcriptions (Teacher#01–Teacher#32).

The interviews were organized into four general themes, i.e.:

1. to characterize the communication tools used in the LMS;
2. to analyze the potential advantages of LMS with regard to collaboration and interaction issues;
3. to identify the main users' concerns about the use of the LMS Moodle; and
4. to understand teachers' and students' expectations about the LMS use in the online teaching-learning process.

In addition, the collected data were analyzed using the content analysis software MAXQDA 2007 (see Sect. 6.4.1) to develop a coding/classification system and were statistically explored using the statistics analysis software SPSS 18. In the content analysis, data were coded into a large number of subcategories, reflecting both the research questions and the themes which emerged from a close content analysis. Three interviews were also randomly chosen for the purpose of testing the coding reliability. As for the statistical analysis, MCA (Sect. 6.4.2) was conducted, since it is considered a useful technique for the structural analysis of multivariate categorical data and also suitable to reduce the dimensionality of the original variables set (Blasius et al. 2009).

8.3 Case Study Results

The system of coding and classification from the content analysis performed in the interviews allowed to associate a set of items to each Category, as shown in Table 8.1. Subcategories in each Category emerged as the most relevant topics from the interviews and the corresponding TUs were codified as a unit of meaning, a word, a phrase or a paragraph, using the semantic criteria in a hermeneutic interpretation. Results for each individual Category are described in the succeeding subsections.

8.3.1 LMS Moodle Tools (Category 1)

As indicated in Table 8.1, in the LMS Moodle category (Category 1), 169 TUs were codified. The subcategory "files/resources" was the most valued by teachers (TU = 49, 29 %), followed by the subcategory "forum" (TU = 39, 23 %). In this context, an interviewee summarized that "I usually use the LMS to provide content, upload documents, and I think that it is very user-friendly." (Teacher#05).

Moreover, the use of the discussion forum is explicitly enunciated by Teacher#26: "I use two different types of forums in the platform—the general forum and the thematic forums -, but this last one more regularly. Although, I perceive that students are not so interested and involved in this part, i.e., reflective asynchronous discussions".

8.3.2 Potential Advantages (Category 2)

Regarding the Category 2, i.e., Potential Advantages, the subcategories most valued were "reorganization" and "collaboration" (TU = 41, 16 %), as tabulated in Table 8.1. In accordance, some benefits were clearly reported by the teachers, e.g., the opportunity to rethink their educational strategies, in other words "(…) another advantage attributed to this LMS is the reorganization of what are the teaching pedagogical strategies." (Teacher#30).

Responses of the interviewees also manifested the importance of network structure, including differentiated instruction, for instance: "(…) the use of the platform as a learning experience, allowing to develop and to explore different tasks and several distinct activities in different groups." (Teacher#20).

Table 8.1 Categories, subcategories and text units (TUs) derived from the content analysis of the teachers' interviews

Category	Subcategory	TU total	TU (%)
1. LMS Moodle Tools	Webmail	8	4.73
	Files/resources	49	28.99
	Student activity report	15	8.88
	Quiz	10	5.92
	Label	8	4.73
	Wiki	6	3.55
	Glossary	11	6.51
	Chat	6	3.55
	Work assignment	17	10.06
	Forum	39	23.08
	Total	*169*	*100.00*
2. Potential Advantages	Courses at postgraduate level	21	8.40
	Usability	13	5.20
	Content repository	20	8.00
	Reorganization	41	16.40
	Teacher-student interaction	15	6.00
	Efficiency in learning	19	7.60
	Communication	30	12.00
	Accessibility	27	10.80
	Sharing information	23	9.20
	Collaboration	41	16.40
	Total	*250*	*100.00*
3. Limitations	Online safety control	12	8.28
	Synchronous discussion	4	2.76
	Upload video files	6	4.14
	Limited-capacity system	8	5.52
	Lack of ICT knowledge	25	17.24
	Update documents	5	3.45
	Instructional design	4	2.76
	Socio-cultural barriers	15	10.34
	High number of students	6	4.14
	Lack of content management	28	19.31
	Lack of time	32	22.07
	Total	*145*	*100.00*
4. Suggestions	Better text-editor functions	2	1.40
	Online tasks	8	5.59
	Curriculum content re-adaptation	21	14.69
	Creation of a co-research space	2	1.40
	Interoperability with other systems	13	9.09
	Faculty training	27	18.88
	E-teaching support services	10	6.99
	Definition of e-assessment criteria	22	15.38
	Other suggestions	38	26.57
	Total	*143*	*100.00*

8.3.3 Limitations (Category 3)

In the Category 3, i.e., Limitations, 145 TUs were identified. The subcategory most mentioned was "lack of time" (TU = 32, 22 %), followed by the one of "lack of management content" (TU = 28, 19 %) (Table 8.1).

Accordingly, two interviewees emphasized the following arguments: "There are some tools that I still do not use but I could use… However, I need more time to develop these technical skills, sometimes I feel that I do not have enough experience to use them." (Teacher#22); and "(…) there are various communication tools that I do not use, because I do not know how to use them, it is kind of a… trial-and-error learning process." (Teacher#07).

8.3.4 Suggestions (Category 4)

Concerning the Category 4, i.e., Suggestions, 143 TUs were codified and the most valued subcategories were "faculty training" (TU = 27, 19 %) and "other suggestions" (TU = 38, 27 %), as indicated in Table 8.1.

In this scenario, a teacher stated: "It is important to encourage dissemination, training and expertise, modernizing and improving knowledge. At the beginning of the academic year, the institution could provide some faculty training in different areas, for example, how to use some technological tools (…)" (Teacher#31). In addition, an interviewee also suggested that: "There must be a common effort to increase the use of technologies as truly pedagogical communication tools. Besides, it would be extremely important to give more information and better technical support to teachers." (Teacher#10). Thus, both faculty training and technological knowledge seem to be inseparable issues for the purposes of personal and professional confidence, i.e., personal teaching efficacy.

8.3.5 Identification of the MCA Dimensions

From the interviews' content analysis, some categories emerged as the most important ones. In turn, the results of the MCA allowed data clustering into four different teachers' profiles regarding the CMS use. In order to determine the reliabilities of the dimensions and to assess their internal consistency, *Cronbach's alpha* (α) was calculated, and the obtained values were between 0.779 and 0.846 for Dimensions 1–4, as tabulated in Table 8.2. This indicates a good internal consistency and reliability.

In addition, the variance accounted for the total (eigenvalue) and inertia for each dimension are also provided in Table 8.2 (in a descending order). As it has mentioned in Part II, the eigenvalue can be seen as the total sum of squared

Table 8.2 The model summary of the number of dimensions identified. The dimensions are displayed in a descending order, according to the amount of variance accounted

Dimension	Cronbach's alpha	Variance accounted for total (Eigenvalue)	Inertia
1	0.872	4.771	0.367
2	0.846	4.411	0.339
3	0.840	4.192	0.322
4	0.779	3.554	0.273
Total		16.928	1.302
Mean	0.839[a]	4.232	0.325

[a] Mean Cronbach's alpha is based on the mean Eigenvalue

component loadings in each dimension, while the inertia quantifies the explained variance by each dimension, ranging from 0 to 1 (see also Sect. 6.4.2). Note that as more closely the inertia appears to the upper limit, more variance is explained by the specific dimension.

After examining the model summary of Table 8.2, it is important to spatially understand the interrelationships between the variables (categories). To facilitate this, for each variable, a discrimination measure, which can be regarded as a squared component loading, was computed for each Dimension, tabulated in Table 8.3. This measure is also the *variance of the quantified variable* in that Dimension.

The Dimensions in Table 8.3 are ordered in a descending order of eigenvalue (see Table 8.2). According to the results of Table 8.3, a reduction of the variables number per dimension could be achieved, when considering only those that exhibited a discrimination measure over a common threshold, i.e., >0.5 (denoted in bold). Generally speaking, here we are trying to reduce the dimensionality of a

Table 8.3 The discrimination measures per variable and dimension derived from the MCA. The numbers in boldface denote values over 0.50

Variable (subcategory)	Dimension			
	1	2	3	4
Files/resources (FI)	**0.999**	0.060	0.169	0.449
Glossary (GL)	**1.000**	0.040	0.047	0.340
Content repository (CR)	**1.000**	0.497	0.356	0.166
Teacher-student interaction (TS)	**0.842**	0.044	0.213	0.235
Wiki (WK)	0.055	**0.610**	0.343	0.181
Chat (CH)	0.122	**0.579**	0.191	0.216
Label (LA)	0.167	**0.548**	0.035	0.137
Courses at postgraduate level (CP)	0.001	**1.000**	0.092	0.022
Work assignment (WA)	0.237	0.150	**1.000**	0.162
Quiz (QZ)	0.090	0.246	**0.972**	0.128
Sharing information (SI)	0.029	0.263	0.018	**0.575**
Online tasks (OT)	0.100	0.053	0.359	**0.606**
Usability (US)	0.129	0.321	0.397	0.337

set of variables in much the same way as factor analysis; that is, looking for common factors which identify the relationships between the variables (categories) by explaining a maximum amount of variability. The aim is similar to principal component analysis, apart from the fact that the variables are categorical, so the missing link is the quantifications given to the categories.

For better understanding the role of each dimension in the explanation of each variable, the corresponding 2/3-dimension Line Plots (2D/3D-LPs) have been produced. In particular, Fig. 8.1 depicts the 2D-LPs for the case of teachers for all unique combinations of the dimension pairs; similarly, Fig. 8.2 depicts the corresponding 3D-LPs.

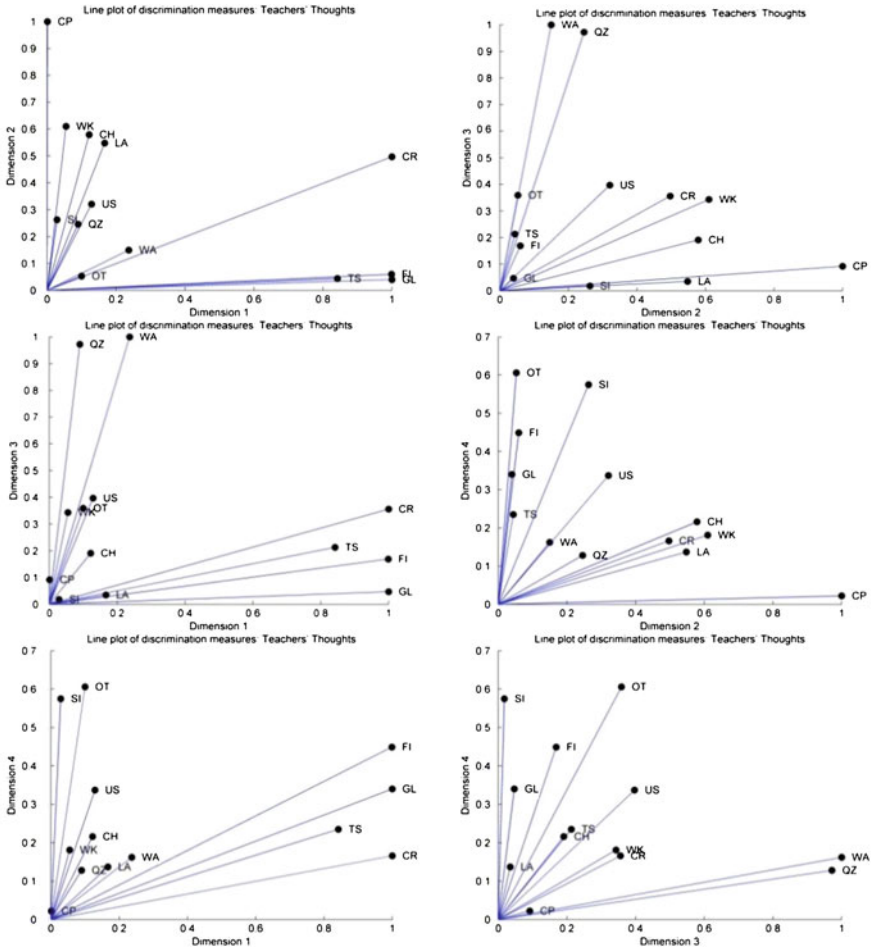

Fig. 8.1 2D Line Plots for all unique combinations of the dimension pairs. The abbreviations correspond to the variables as coded in Table 8.3

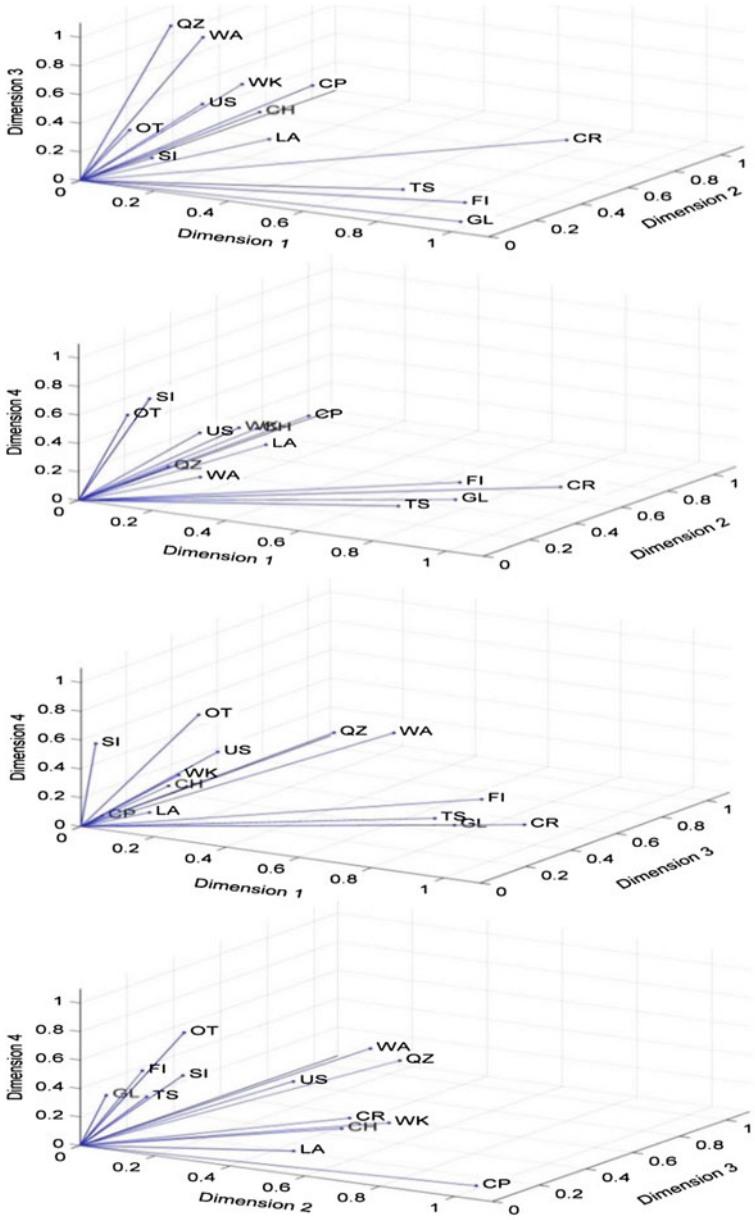

Fig. 8.2 3D Line Plots for all unique combinations of the dimension triplets. The abbreviations correspond to the variables as coded in Table 8.3

From the 2D/3D-LPs depicted in Figs. 8.1 and 8.2, along with the distribution of the bold values in Table 8.3 (no variable overlap across the dimensions), it is clear that the variance of the important variables (those in bold in Table 8.3) is expressed by a sole dimension. For example, Dimension 1 explains Files/resources (FI), Glossary (GL), Content repository (CR), and Teacher-student interaction (TS) and none of the rest variables included in Table 8.3. When focusing at these variables in the corresponding 2D/3D-LPs (see Figs. 8.1 and 8.2), their lines have high value (most of them equal to one) across the axis of Dimension 1 and significantly smaller values (definitely less than 0.5) across the Dimension J, where $J = 2, 3, 4$. The same holds when focusing to the rest of the dimensions and their corresponding variables, accordingly.

From the grouping of the variables belonging to each dimension (see Table 8.3), a characterization of the latter is feasible, according to the corresponding underlying profile. Consequently, the identified dimensions are corresponded to the following *a posteriori* interpretation, namely: Dimension 1: Activities; Dimension 2: Interaction; Dimension 3: Assessment; Dimension 4: Collaboration. The role of these dimensions in the structure of the profiles of teachers is described and discussed in detail in the discussion section that follows.

8.4 Discussion

8.4.1 Activities (Dimension 1)

Dimension 1 explains the valorization of activities developed by teachers when using the LMS. Statistical analysis results (*eigenvalue* = 4.771, *inertia* = 0.367, Table 8.2) reveal that there is a highly positive association between the use of asynchronous tools (Files/resources, Glossary), the Content repository, and the Teacher-student interaction.

The significant increase of the Free/Libre Open Source Software (FLOSS) ecosystems has represented an evident impact on the education system. This philosophy, based on open and self-organization communities (e.g., the CMS Moodle) has been associated, for instance, with the concepts of asynchronous structures and collaborative activities (Yengin et al. 2010). These applications, supported by a model-based interoperability, seem to facilitate the process of creating, editing, formatting, reuse and export learning content with, for example, SCORM standards (e.g., XHTML editor eXe, http://exelearning.org), offering multi-lingual and multi-cultural environments (Stamelos 2011). In other words, the teachers can explore, adopt and adapt these tools for personal use (Dori 2008), in order to facilitate the reusability and interoperability of teaching and learning activities.

Nevertheless, most teachers tend not to reveal *technological content knowledge* and *technological pedagogical knowledge* to empower them to build their Web

pages and their collaborative e-activities (Mishra and Koehler 2006). This was also seen in the analyzed data here, as one of the interviewees reveals that:

> Even responding to emails, sometimes, it becomes a rather boring, tiresome task. Right now, I am also using some resources, forum postings and assignments. However, I think that student assessment and the teaching process are not so easy to do in an online environment (Teacher#26).

Unfortunately, some studies have revealed that some LMSs are seen as a tool set for information distribution and administrative effectiveness, rather than a system with potential to improve teaching and learning activities (Black et al. 2007). However, most recent research underlines that the increase of interaction between the teachers and students tends to allocate a more flexible and adaptable learning, allowing more individualization of learning and accessibility at anytime, anywhere (Bates and Sangrà 2011; Ifenthaler and Pirnay-Dummer 2011).

At the end, in an educational context, the use of asynchronous, flexible and versatile tools in a structured, sustainable and efficient way seems to demonstrate a relevant advantage to incorporate (collaborative) online learning activities.

8.4.2 Interaction (Dimension 2)

Dimension 2 recognizes the teachers' understanding about the quality of interaction between teacher and student in blended teaching context. Considering the statistical analysis results (*eigenvalue* = 4.411, *inertia* = 0.339, Table 8.2), it seems reasonable to state that there is a strong relationship between both the use of distinct communication tools (Wiki, Chat, Label) and education level, i.e., LMS use is more effective at the Postgraduate Level—Master's or PhD, when compared to undergraduate level.

In the context of online distance education environments, the interaction is considered as a key issue, once it may condition the success of the learning outcomes and the quality of online learning *per se* (Abrami et al. 2011). In this dimension, teachers seem to reveal some implicit knowledge of several synchronous and asynchronous tools. Muirhead and Juwah (2004) characterize the interaction dimension as a set of: i) abstract characteristics (e.g., interpersonal communication) and ii) interaction types (e.g., learner-instructor interaction), in which communication can be established synchronously or asynchronously. As to this, one of the interviewees stated that: "I need more time to feel comfortable with interactive tools, such as wikis, assignments, forums or a chat (…) because the use of technology is very time-consuming." (Teacher#03).

The interactive nature of learning communities may, however, enrich and reinforce students' individual learning experiences; Hirumi (2009) points out that "Due to the relatively constrained nature of learner-instructor and learner–learner interactions in an online environment, self-regulation may be particularly important for distance learners" (p. 205). Considering the empirical results of this case

study, it seems also important to recognize that there are relevant differences in interaction between subject matter and, overall, the interaction is stronger in a graduate rather than in an undergraduate teaching level (Smeby 1998).

In this scenario, the online teaching modules seem to require a structured and differentiated database, responding to the genuine needs of students (Palaigeorgiou et al. 2011), of different curricula, as well as of different levels of education.

8.4.3 Assessment (Dimension 3)

Dimension 3 identifies the teachers' knowledge of how to assess the students' progress in a LMS. Statistical analysis results (*eigenvalue* = 4.192, *inertia* = 0.322, Table 8.2) suggest that there is a positive relation with both use of Work assignments and online activities (Quiz).

The opportunity for monitoring the students' evolution and identifying the students' learning needs within a LMS appears as an important challenge in the process of knowledge co-construction, once it may support teachers to provide students formative feedback on their learning development. Accordingly, Tan (2007) states that:

> Academics may have to allow, or perhaps encourage, their students to question and challenge the relative reliabilities of existing assessment and self-assessment practice in order to sustain their future ability to conduct their own self-assessment (p. 124).

Additionally, other issues related to the pedagogical design, assessment activities, and feedback (interactive and formative) seem to be important features that allow teachers to validate and ensure online formative assessment in higher education (Gikandi et al. 2011). In this sense, an interviewee also argued that: "I think that online resources, weekly assignments and different ways of using formative assessment tools promote the students' motivation and engagement in the learning process." (Teacher#20). As stated succinctly by Visser (2005) "Practice, feedback, and assessment are critical aspects of instructional effectiveness." (p. 295).

Perhaps, both the academic commitment and the negotiation of interpersonal accountability of students in the teaching-learning process seem to represent critical indicators for the effectiveness and sustainability of online DE.

8.4.4 Collaboration (Dimension 4)

Dimension 4 explains the valorization of the LMS to support the collaboration network. As to this, a positive relationship (*eigenvalue* = 3.554, *inertia* = 0.273, Table 8.2) was observed between the Sharing Information and Online Tasks.

In DE, the dynamics of the collaboration process is considered a complex phenomenon based upon a set of interactions with various complexity levels, for

example, lesson structure or learning tasks (Tutty and Klein 2008). For instance, an interviewee stated that:

> I believe that the main advantages in using LMS platform are the possibility of re-designing pedagogical strategies, interdisciplinary collaboration and interactive network. But sometimes it was difficult for me to find the appropriate tools (Teacher#30).

Accordingly, in this particular dimension, teachers seem to be more concerned with real opportunities and creative approaches applying social media (Bosman and Zagenczyk 2011) in collaborative work, i.e., how to use the features available in LMS in order to enhance social work research, networking or knowledge-sharing network. According to Conrad and Donaldson (2010) "Engaged learning is a collaborative process in which the teacher and student are partners in construction knowledge and answering essential questions" (p. 8). Moreover, technology-enabled e-collaboration has been also identified as important practice in modern institutions. There are a number of potential e-collaboration technologies (e.g., wikis, audio/video conferencing, chat, email) that can be used in communities of practice and useful for helping teachers in accomplishing their online tasks; Stokes et al. (2008), however, argues that "With adaptability identified as the central issue, researchers and organizations can proceed with unified framework and formulate a coherent path to integration with e-collaboration technologies" (p. 9).

In addition, some authors also reiterate that collaborative learning can assist students to feel more interactive and also exerts a positive influence in terms of motivation, behavior and self-determination, as well as engagement in learning activities (Reeve and Tseng 2011; Wijnia et al. 2011).

8.5 Final Considerations

In order to reach a significant improvement in the quality of the online teaching-learning process, it seems clear that the most innovative changes should embrace effective e-strategies; pro-action at this level, however, requires both institutional commitment and academic resilience. The results of the presented case study suggest that the academic community (i.e., teachers) is enthused to use the LMS Moodle and the blended environment seems to ensure innovation, openness and flexibility.

Overall, in terms of rethinking, reviewing and re-constructing online education, the empirical results also point out the importance and need to create supportive environments for a more comprehensive blended structural design (Sarirete et al. 2008). As for the adopted MCA, it seems to represent a useful technique to identify profiles and their interdependencies, and to show the structural complexity of data from a large number of categorical variables. The application of this technique here allowed identifying four distinct profiles of teacher: (1) activities-oriented, (2) interaction-oriented, (3) assessment-oriented, and (4) collaboration-oriented.

Under this complex multifaceted environment, it seems imperative to think holistically and systemically in creating a sustainable higher education system. It is, however, important to remind that "Probably the most serious problem we have identified is the general lack of imagination about the possibilities of technology for meeting the needs of today's students" (Bates and Sangrà 2011, p. 218).

In closing, this chapter can be considered as a contribution to promote a renewed attention to the different dimensions of educational knowledge of four particular domains, namely *activities, interaction, collaboration* and *assessment*. Once identified these profiles, one can adjust the educational practice in order to promote a more harmonious, innovative and comprehensive, academic, community. Despite the limited interview sample and the small-scale character of the presented case study, it, actually, addresses in-depth relevant issues on educational processes in b-learning environments, in the specific context of higher education, aiming at a more educated, interactive and collaborative online community.

In terms of understanding and responding to the academic needs, this case study provided a comprehensive support for choosing adjustable instructional strategies in distinct dimensions of educational knowledge, considering solely the teacher's profiles. The second complementary pillar, i.e., student's profiles, is approached through the case study of the next chapter.

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Chapter 9
Towards an Enriched LMS for B-Learning Environment: Students' Profiles

9.1 Introduction

The case study of this chapter sheds light upon the students' profiles within the b-learning context and serves as the complementary chunk to the teachers' profiles presented in the previous chapter. This combined knowledge of both profiles could be used for the enhancement of LMS in HE, since it reflects the attitude and beliefs of the main stakeholders in the OLE; hence, it offers the appropriate focus to users' issues that should be taken into account in the efficient design and architecture of more intelligent LMS. Nevertheless, before embarking for the exploration of the students' profiles when interacting with the LMS Moodle within the b-learning context, it is useful to describe briefly the factors and main considerations that outline the characteristics of the OLE in general.

Nowadays, there is a clear paradigm shift in higher education from traditional educational environments to online educational ones, which can be seen as a challenge to create an active and interactive learning environment that gives the learner the opportunity to engage and think in multiple ways (Bonk and Reynolds 1997). From the plethora of ICT-based e-learning approaches, b-learning, which combines F2F and online learning, has been considered as "the most common mode of e-learning" (Bates and Sangrà 2011, p. 42). Actually, b-learning meets multiple and differentiated instructional online activities, therefore it has the potential, human and technological, of accommodating students with distinct learning needs.

To improve the quality/optimization of a b-learning process it seems reasonable to take into account both educational resilience and interpersonal engagement, in order to understand constructivist and sociocultural core principles. Furthermore, technological systems, and their analogous tools, can be valuable educational instruments in b-learning, depending on the way they are used. LMSs have been structured to support the latter perspective, assisting to the management of teaching and learning activities in an OLE, such as that of b-learning (Black et al. 2007). A typical LMS embeds a kind of agents that belong to an interactive

S. B. Dias et al., *Towards an Intelligent Learning Management System Under Blended Learning*, Intelligent Systems Reference Library 59, DOI: 10.1007/978-3-319-02078-5_9,

learning environment assisted by mediating tools that support, for example, inter/intra-action, collaboration, training, communication and sharing information amongst the LMS users. Some LMSs, however, are primarily used as a tool set for information distribution and administrative effectiveness rather than a system with potential to improve teaching and learning activities (Black et al. 2007; Kvavik et al. 2004). In this vein, the role of the LMS users should be taken into consideration, so to provide them with a supportive and inclusive environment that delivers enriched educational experiences. Thus, it seems essential to evaluate the multidimensional and dynamic usability nature of a LMS, i.e., effectiveness, learnability, flexibility and the users' attitude (Shackel 2009). From this perspective, some questions arise, regarding the effect of the LMS structure on the students' learning and vice versa, i.e., the perception of the role and functionality of a LMS in their effective learning and social engagement, since, as Jones et al. (2008) suggest, the use of internet-based LMS is not necessarily correlated with student's satisfaction.

Moreover, examination of the way LMS is affected by the learners' profiles is needed, in an effort to incorporate the latter information in the enhancement of its design; this sets the basic rationale and defines the structure of the case study presented in the succeeding sections.

9.2 Case Study Structure

Assessment of students' needs and identification and understanding of their profiles in a specific b-learning context within a LMS environment could shed light upon some specific issues concerning the key factors of the LMS structure and reveal the weaknesses and drawbacks that need further consideration.

Usually, a LMS under the b-learning perspective includes structural parts that assist a managerial administration of the knowledge carriers, realized through an interactive learning environment. Clearly, a set of mediators (i.e., tools that, among others, foster users' inter/intra-actions, collaboration, training, communication, data logging and sharing information) is also necessary to assist the handling of the interactions of the users with the LMS. The role of the LMS is to increase the efficiency of the b-learning that is received by its users, i.e., learners (explicitly) and teachers (implicitly). If we consider the learners' profiles as an additional source of information, then optimization processes could take place that could be fed into the LMS and, by affecting some structural elements, could increase the efficiency of the outputted b-learning to the receivers. This is schematically presented in Fig. 9.1, adapted from Dias and Diniz (2013), where the depicted block-diagram shows an ordinary LMS with its inputs and output, combined with an additional branch (included in the dashed rectangular) that controls the LMS output (efficiency of b-learning).

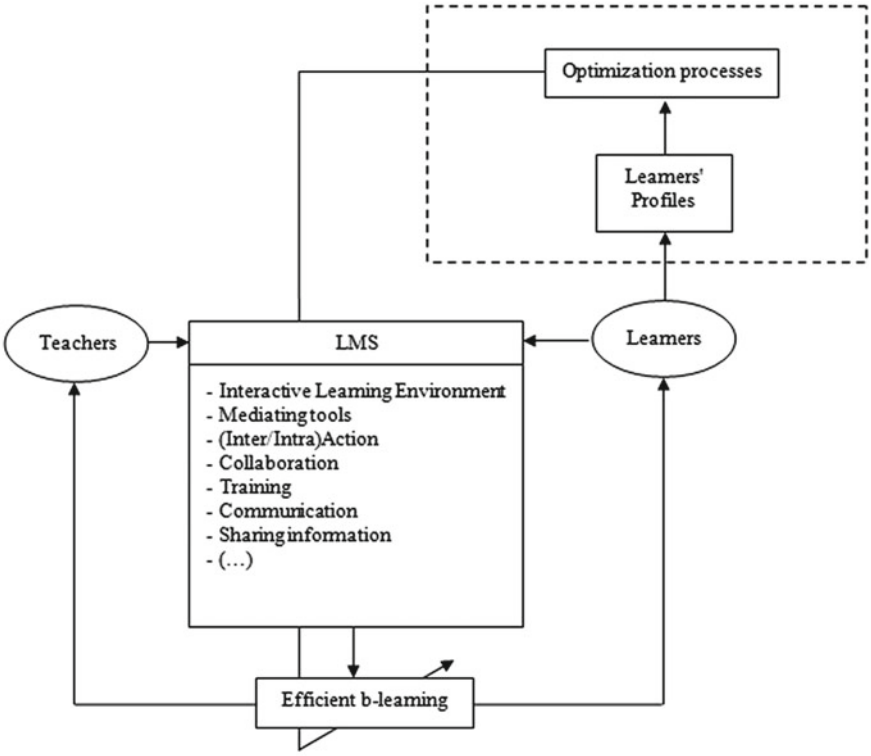

Fig. 9.1 A graphical representation of the case study research design. The *dashed square* denotes the factors introduced in the case study for increasing the efficiency of b-learning (output of the LMS). (Dias and Diniz 2013)

Students' profiles could be considered vital, as the whole process of b-learning is actually designed for them and they are the main receivers of knowledge through their interaction with the LMS environment (individually and/or within groups). Hence, their role in the latter could be approached twofold, i.e., as simple users (passive mode) and as contributors to the enhancement of the LMS functionality by identifying points of improvement and expressing their opinions after its use (active mode). Considering the information from the active mode, the LMS becomes more functional and encourages learners' participation and contributions. In a step further, teachers' profiles could also be incorporated, yet with a reference to the learners' ones, as there is a kind of cause-effect dependency among them.

It is essential to eliminate any potential subjective bias from the students' profiles, fostering the objective dimensions that lie in their responses, as in the active mode they act as a kind of feedback to the LMS. To this end, a series of careful procedural steps were followed, as described in the succeeding subsections.

9.2.1 Participants' Characteristics and Implementation Issues

The perspectives of the students of five different courses (Sport Sciences, Ergonomics, Dance, Sport Management and Psychomotor Rehabilitation) offered by a public HEI, i.e., FHK, were acquired via semi-structured interviews. These courses reflect the core of the curriculum of the specific HEI, involve a high number of students each academic year and offer a distinct LMS Moodle-based b-learning environment.

From a total of around 800 LMS undergraduate users, two distinct groups were formed according to the frequency of LMS usage, i.e., the most active students (Group 1, 18 students) and the less active ones (Group 2, 18 students), resulting in a total number of N = 36 selected undergraduate participants. In this way, the diversity between the learners' groups is taken into account in the data space (deviant sample) (Marshal 1996). This selection was based on three usage indicators that refer to: (i) number of views, (ii) number of contributions, and (iii) total activity in the LMS environment.

In general, the most and less active students were selected in each course, according to number of hits, i.e., total access, allowing to differentiate between Group 1 (Median; Inter-quartile Range [75–25 %] = 2856.5; 1290.3) and Group 2 (Median; Inter-quartile Range [75–25 %] = 737; 623). The distribution of the number of participants for each LMS-based course was similar across the two groups. Moreover, the concept of a random sample was not adopted here, since it is not the most effective way of developing an understanding of complex issues relating to human behavior (Marshall 1996).

From the 36 undergraduate participants involved in the study, 61 % of them was female, while their age ranged from 18 to 48 years. Data were collected at the end of the first semester of the academic year 2010/2011 (January), whereas the 53 % of these participants (19) started to use the LMS (i.e., made their first access) in the academic year 2009/2010. In fact, 33 % (12) of them made their first entry in September 2009 and 47 % (17) reached their peak activity during the 5-month period, from January to May 2011 (see Table 9.1). All participants used b-learning via LMS Moodle for at least 6 months.

9.2.2 Data Analysis

The methodology adopted here for acquiring students' profiles combines both qualitative and quantitative evidence in a synergistic way, i.e., using qualitative data for understanding the rationale and theory underlying relationships revealed in the quantitative data and, in turn, avoiding any false impressions and subjective interpretations from qualitative data.

Table 9.1 The distribution of the students' experience in the LMS use in a chronological order. (Dias and Diniz 2013)

Categories/time period	Number of students (N = 36)	
	Frequency	Percentage (%)
First access in LMS (*academic year*)		
2008/2009	2	5.56
2009/2010	19	52.78
2010/2011	15	41.67
First entry in a subject (*month, year*)		
September, 2008	2	5.56
September, 2009	12	33.33
October, 2009	5	13.89
November, 2009	1	2.78
January, 2010	1	2.78
September, 2010	10	27.78
October, 2010	5	13.89
Activity peak (*month, year*)		
October 2009 to January 2010	8	22.22
February 2010 to July 2010	4	11.11
August 2010 to December 2010	7	19.44
January 2011 to May 2011	17	47.22

The qualitative evidence was based on a semi-structured F2F interview of the learners in the active mode, with questions previously validated from experts in the field. The interviews were organized into the same four general themes adopted for the case of teachers (see Sect. 8.2.2), structuring the same Categories, i.e.:

- Category 1 enabled the characterization of the communication tools used in the LMS environment (*LMS Moodle tools*);
- Category 2 aimed to analyze the potential benefits of the LMS concerning the collaborative and interactive network (*Potential strengths*);
- Category 3 aimed to understand the concerns about the use of LMS (*Weaknesses*); and
- Category 4 intended to retrieve data regarding the students' expectations to future LMS usage (*Students' suggestions*).

The acquired interviews were audio-recorded and verbatim transcribed, i.e., 36 protocols were obtained through the interview transcriptions (Student#01–Student#36) and formatted so they could be fed in the MAXQDA software. Three interviews were also chosen randomly for the purpose of testing the coding reliability.

The combination of the qualitative data from Categories constructed the data space, which reflects information about the students' satisfaction with the use of the b-learning in the LMS environment, their perception of it and the instructional strategies/tools were used. The qualitative data space is then subjected to

quantitative analysis using the content analysis software MAXQDA 2007 (see Sect. 6.4.1) to develop a classification/coding system, i.e., construction of the quantitative data space. The latter, then, was coded into a large number of subcategories, reflecting both the research questions and the themes which emerged from a close analysis. The coded data produced were statistically explored and articulated using the statistics analysis software SPSS18. Similarly to the case of teachers, a MCA (Sect. 6.4.2) was then conducted, as it is generally used as an exploratory approach to unearth empirical regularities of a dataset (Benzecri 1992). The first three dimensions of MCA that explain most inertia and have high eigenvalues were kept. In addition, the threshold value for the weighted correlations adopted in the MCA to perform dimensionality reduction was equal to 0.5, so only the important variables to be considered per dimension. Finally, the combination of qualitative and quantitative analyses established a methodological triangulation (Denzin 1970; Fielding 2009). The derived analysis results are described in details in the following section.

9.3 Case Study Results

Similarly to the teachers' case (see Sect. 8.3), the content analysis using MAXQDA software performed in the interviews allowed to associate a set of items, i.e., Subcategories, to each aforementioned Category. Subcategories in each Category emerged as the most important topics from the interviews corresponding to Text Units (TUs). The latter were codified as a unit of meaning, a word, a phrase or a paragraph, using the semantic criteria in a hermeneutic interpretation. Similarly to the case of teachers (Table 8.1), the emerged Subcategories per Category along with the corresponding total TUs are tabulated in Table 9.2, followed by a description of the results for each individual Category.

9.3.1 LMS Moodle Tools (Category 1)

As specified in Table 9.2, in the LMS Moodle Tools category (Category 1), 252 TUs in total were codified. The Subcategory "Linkability to other systems" was the Subcategory most valued by the students (TU = 53, 21 %), followed by the Subcategory "Files/resources" (TU = 50, 20 %) (Table 9.2). In this context, the use of other systems (e.g., class mail, blogs) is reinforced by several of the interviewed students, for instance:

> Class mail is restricted to students and teachers do not have access to it. We usually use the LMS to upload documents, sometimes to communicate with teachers. The LMS is an official system and class mail is a more informal online environment, which allows sharing some information or class notes privately (Student#05).

Table 9.2 Subcategories per Category that emerged from the content analysis of students' interviews using MAXQDA software, along with the corresponding total TUs. (Dias and Diniz 2013)

Category	Subcategory	TU Total	TU (%)
1. LMS Moodle Tools	Quiz	6	2.38
	Wiki	10	3.97
	Webmail	24	9.52
	Forum	31	12.30
	Label	13	5.16
	Files/resources	50	19.84
	Chat	13	5.16
	Glossary	8	3.17
	Assignment	44	17.46
	Linkability to other systems	53	21.03
	Total	*252*	*100.00*
2. Potential strengths	Teacher-student interaction	36	14.52
	Courses at postgraduate level	2	0.81
	Sharing information	17	6.85
	Content repository	59	23.79
	Organization	20	8.06
	Efficiency in learning	9	3.63
	Communication	31	12.50
	Accessibility	19	7.66
	Usability	28	11.29
	Self-regulated learning	15	6.05
	Collaboration	10	4.03
	Total	*248*	*100.00*
3. Weaknesses	Students' low ICT knowledge	63	22.99
	Technical issues	36	13.14
	Online safety	8	2.92
	Age and sociocultural differences	20	7.30
	Teachers' low ICT knowledge	46	16.79
	Lack of time	8	2.92
	High number of students	17	6.20
	Teachers' beliefs, subject matter	43	15.69
	Techno-pedagogical knowledge	33	12.04
	Total	*274*	*100.00*
4. Suggestions	Multi-tool systems	20	13.07
	Content reorganization module	20	13.07
	Formative feedback	19	12.42
	Faculty training	34	22.22
	Students' ICT training	13	8.50
	Assessment tasks	34	22.22
	Others	13	8.50
	Total	*153*	*100.00*

Therefore, the LMS Moodle seems to be more used as a content repository rather than a collaborative learning environment. Student#36 reinforces this perspective when he states: "Basically, I use the LMS to download subject contents, pdf documents, lecture notes or slides".

9.3.2 Potential Strengths (Category 2)

In turn, concerning the Potential Strengths category (Category 2), 248 TUs in total were codified (Table 9.2), with the Subcategories most valued being "Content repository" (TU = 59, 24 %) and "Teacher-student interaction" (TU = 36, 15 %). Similarly to the teachers' case (Sect. 8.3.2), students exposed relevant advantages in using a distance learning system, e.g., to support asynchronous collaborative activities and/or to provide meaningful opportunities of self-regulated learning (Table 9.2). For instance, some students revealed: "The LMS is very important to download documents, slides, study notes, which help us a lot (…) it is extremely convenient and easy to use." (Student#21), and "I usually use the LMS to download documents, music, videos (…) information that we really need to write our essays." (Student#07). It was also possible to infer that students consider the LMS Moodle as a social media tool; as reported by one student: "The LMS is an easy way to communicate with teachers, e.g., to submit and share documents" (Student#04).

9.3.3 Weaknesses (Category 3)

In the Weaknesses category (Category 3), 274 TUs in total were categorized (Table 9.2). The Subcategory "Students' low ICT knowledge" corresponds to the highest TU number (TU = 63, 23 %), followed by the Subcategory "Teachers' low ICT knowledge" (TU = 46, 17 %) (Table 9.2). Accordingly, the lack of technology knowledge of both students and teachers tends to appear as an important limitation. In this context, two interviewees considered that:

> In terms of interaction, I do not know how to use correctly some tools available online learning platform. I know that the LMS has many potential tools, like chat rooms or discussion forum, which allows us to interact and share information with colleagues. But, I only use the LMS to download slides presentations, lecture notes or supplementary texts (Student#11);

and

> Some teachers indicate potential advantages in the use of the LMS and others are much more reluctant to use it, because they only post presentation slides (used in F2F sessions) in the platform. I think that the main reason why they prefer to use traditional teaching activities is technophobia, the lack of time, and some do not know how to use the online tools (Student#23).

9.3.4 Suggestions (Category 4)

Regarding the students' Suggestions category (Category 4), referring to optimization of the LMS use, 153 TUs in total were classified (Table 9.2). The Subcategories "Faculty training" and "Assessment tasks" correspond to the highest amount of TUs coded in this category (TU = 34, 22 %) (Table 9.2). These issues were highlighted by the perspective of a student when he states:

> I think that they [the teachers] need to develop technological knowledge, probably through faculty training, and so that they can develop activities using different tools, such as wikis, discussion forums (…) or create learning sequences, such as a Learning Activity Management System activity (Student#32).

Still another student indicated that:

> The use of the LMS should be mandatory; teachers should stimulate the use of the platform by defining assignments; with the (mandatory) participation in discussion forums, students would be more motivated to use the LMS (Student#34).

9.4 MCA Dimensions Identification

From the students' interviews content analysis, some categories emerged as the most important ones. Similarly to the case of teachers, MCA results allowed data clustering into three different students' profiles (Dimensions 1–3) regarding the CMS use. The *Cronbach's alpha* (α) was considered to determine the reliability and to assess the internal consistency of these dimensions (Benzecri 1992), and the obtained values were between 0.961 and 0.942, for Dimensions 1–3, as shown in (Table 9.3). This indicates a good internal consistency and reliability in the definition of the students' profiles.

After examining the model summary, it is important to spatially understand the interrelationships between the variables (categories). The dimensions in Table 9.3 are ordered in a descending order of eigenvalues and a reduction of the variables

Table 9.3 The model summary of the number of dimensions identified. The dimensions are displayed in a descending order, according to the amount of variance accounted

Dimension	Cronbach's Alpha	Variance accounted for Total (Eigenvalue)	Inertia
1	0.961	7.902	0.493
2	0.930	6.270	0.392
3	0.942	4.173	0.261
Total		18.345	1.146
Mean	0.946[a]	6.115	0.382

[a] Mean Cronbach's Alpha is based on the mean Eigenvalue

number per dimension could be achieved when considering only those that exhibited a discrimination measure over a common threshold, i.e., >0.5 (denoted in bold), as shown in Table 9.4. The interpretation of the results is facilitated with the 2D/3D-LPs for the case of students for all unique combinations of the dimension pairs and the one triplet, depicted in Fig. 9.2.

From Fig. 9.2 and the non-overlapping of the important variables across the three dimensions (see bold values in Table 9.4) it is clear that (similarly to the teachers' case), each dimension explains a unique set of variables. For example, Dimension 1 explains Webmail (WM), Chat (CH), Teacher-student interaction (TS), Sharing information (SI), Self-regulated learning (SL), Accessibility (AC), and Efficiency in learning (EL). As the discriminate measures of the latter variables are higher than 0.5 and, in general, converge to 1.0, the corresponding lines in the 2D/3D-LPs will have high values across Dimension 1 and small ones across the rest of the dimensions (in all combinations of pairs and triplet). The same behavior is noticed for Dimension 2, whereas Dimension 3 explains only one variable (Teachers' beliefs, subject matter (TB)). Finally, it is noteworthy that the variables Collaboration (CL), High number of students (HN), and Label (LB) are not explained by any dimension; to this end, they are ignored in the rest of the analysis.

From the grouping of the variables belonging to each dimension (see Table 9.4), a characterization of the latter is feasible, according to the corresponding underlying profile.

Table 9.4 The discrimination measures per variable and Dimension derived from the MCA. The Subcategories per Dimension that their weighted correlation exhibits values >0.5 are denoted in bold

Variable (Subcategory)	Dimension		
	1	2	3
Webmail (WM)	**1.000**	0.056	0.112
Chat (CH)	**0.876**	0.387	0.164
Teacher-student interaction (TS)	**1.000**	0.177	0.323
Sharing information (SI)	**0.861**	0.028	0.433
Self-regulated learning (SL)	**0.650**	0.342	0.014
Accessibility (AC)	**1.000**	0.341	0.239
Efficiency in learning (EL)	**1.000**	0.001	0.056
Teachers' beliefs, subject matter (TB)	0.060	0.106	**1.000**
Lack of time (LT)	0.036	**0.619**	0.356
Linkability to other systems (LN)	0.228	**1.000**	0.436
Glossary (GL)	0.192	**0.647**	0.030
Students' ICT training (ST)	0.291	**0.894**	0.097
Usability (US)	0.334	**1.000**	0.496
Collaboration (CL)	0.030	0.376	0.091
High number of students (HN)	0.021	0.122	0.138
Label (LB)	0.323	0.174	0.188

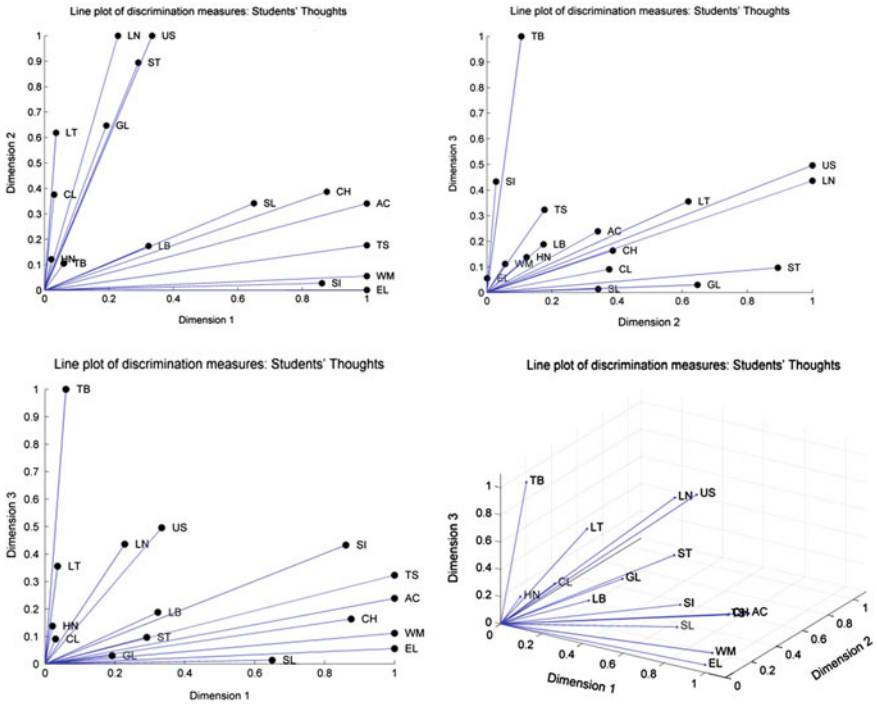

Fig. 9.2 2D/3D Line Plots for all unique combinations of the dimension pairs/triplets. The abbreviations correspond to the variables as coded in Table 9.4

Consequently, the identified dimensions are corresponded to the following *a posteriori* interpretation: Dimension 1-Interactive Learning Environments; Dimension 2-Training; and Dimension 3-Teachers' beliefs and subject matter, which are separately discussed in the following section.

9.5 Discussion

9.5.1 Interactive Learning Environment (Dimension 1)

This dimension explains the type of learning environment valued by the students. Statistical results (*eigenvalue* = 7.902, *inertia* = 0.493, Table 9.3) suggest that there is a highly positive relationship between the use of distinct—synchronous and asynchronous—communication tools (Webmail, Chat), the benefits of interaction (Teacher-student interaction, Sharing information), the sustainable education (Self-regulated learning), and the user-friendliness (Accessibility, Efficiency in learning).

In fact, interactive environments are determinant in distance learning as they may condition the success of the learning outcomes and the quality of online learning *per se* (Abrami et al. 2011; Muirhead and Juwah 2004). According to some researchers, the creation of a learner-centered LMS implies particular interaction relations associated with online learning, namely, learning-interface, learner-self, learner-content, and learner-learner (Chou et al. 2010; Hirumi 2009). Thus, the features of LMS will allow an adjustable and dynamic ecosystem that can integrate different interactive learning activities.

Based on the students' responses, the empowerment and continuous improvement of LMS interactivity may result in higher levels of students' satisfaction; in their own words:

> I believe that some teachers are more comfortable using interactive tools, such as wikis, assignments, forums or a chat than others (…) depends on the subjects, but we have more motivation and high-interest for interactive activities; I think that the learning process is, this way, easier and more attractive (Student#17).

In this vein, interactive environments with a diversified and integrated approach may enrich and reinforce students' intrinsic interest in academic online activities, namely to a motivational process promoting self-regulated learning. Various authors have also demonstrated that the structure of learning communities is a particularly important issue that should be considered to develop processes of higher-order thinking and contextual learning (e.g., through social interactions) (Redecker et al. 2009; Zhao and Kuh 2004). For instance, more recent interactive technologies, such as mobile social computing, can be integrated to encourage student communication, collaboration and creativity (e.g., micro-blogging, life-streaming, social tagging, podcasting, social networking, media sharing) (Gupta et al. 2009; Redecker et al. 2009). This can also contribute to understand and respond to both students' social needs and cultural diversity. According to McGuire (1996), interactive learning environments represent a blend of both multimedia and hypertext, which integrate, for example, analogous/associative characteristics, accessibility, linkability, intuitiveness, and nonlinear organization. As a result, the combination effect of nonlinear, multisensory, and multimodal interactive systems seems to offer strong potential to expand b-learning scenarios.

9.5.2 Students' Training (Dimension 2)

The relevance of training towards a proficient LMS usage is identified through this dimension. Considering the statistical results (*eigenvalue* = 6.270, *inertia* = 0.392, Table 9.3), there is a positive association between lack of time, the lack of interoperable systems (Linkability to other systems), the lack of technological knowledge (Students' ICT training), and the LMS Usability.

The new dimensions of community and identity (Wenger 1998; Zhou 2011) that emerge in the globalization era justify new approaches in the design,

implementation and development of the teaching–learning process. Nowadays, researchers have stressed that faculty members need more time to improve their experience in technology-based instruction, e.g., e-moderation (Salmon 2000) and technology integration (Mishra and Koehler 2006), trying to improve technological, methodological and strategy knowledge for their own and for their students (Howell et al. 2004). According to the students' responses, the lack of time to explore the potential of the LMS Moodle is still a major limitation. One of the interviewees assumed that:

> I need more time to explore several activities and useful tools of the Moodle platform, such as chats, wikis, and forums (…) or how to send assignments to the teacher! In some situations I do not know how to effectively use the platform tools and, for example, how to communicate with my colleagues (Student#11).

Hence, ICT knowledge, in the context of OLEs appears to represent an emerging need, requiring "a new set of skills for most educators and learners" (Simonson 2005, p. 284). In an extension to this, Oh and Park (2009) argued that the lack of faculty motivation and enthusiasm to integrate technology into their DE courses may represent the most important challenge for the implementation of effective blended teaching. Unexpectedly, the results of a study revealed that more than 36 % of students surveyed consider not needing supplementary training in the use of ICT in their online courses (Kvavik and Caruso 2005). However, according to Kenny and Pahl (2009), in an active learning approach, learning is often associated with knowledge acquisition and skills training, hence students would achieve better learning performance and higher levels of satisfaction if they are adequately trained for the effective LMS usage.

9.5.3 ICT Teachers' Beliefs and Differentiation (Dimension 3)

This dimension recognizes the importance of teachers' ICT knowledge in the LMS usage being solely constituted by one subcategory (Teachers' beliefs, subject matter, *eigenvalue* = 4.173, *inertia* = 0.261, Table 9.3).

Teachers' beliefs, particularly sociocultural beliefs, seem to represent a large role on how distance learners from different parts of the world interact with teaching and learning systems. In particular, certain internal constraints (e.g., teachers' beliefs, teachers' self–efficacy, teachers' attitudes) and external constraints (e.g., access, training, local support) were identified as relevant barriers that influence the teachers' ICT implementation efforts (Ertmer 1999). Accordingly, both cultural identities and thinking processes have been highlighted as important obstacles to the integration of ICT in the educational context (Richards 2004; Watson 2001).

Equally important, some studies have pointed out that only a few teachers are prepared to integrate ICT into their teaching activities, even though there is an

increasing awareness of teachers as to the value of training as to ICT use (Dawes 1999; Kirkup and Kirkwood 2005). From the students' standpoint, some differences in teachers' behavior are associated with ICT knowledge and intrinsic motivation. An interviewee stated that:

> I think that some teachers are more familiar with the technology, and others just do not use the tools and resources that are available in the LMS (…) they need to be more self-confident about using the LMS for teaching-learning activities (Student#32).

There is also evidence about the disciplinary differences, which are critical factors in the design and improvement of online courses (Arbaugh et al. 2010; Smith et al. 2008). For instance, distance learning in applied disciplines (e.g., Engineering, Nursing, and Education) appears to be more diversified and more geared towards a community of practice, compared to the pure disciplines (e.g., Natural Sciences, Humanities, Social Sciences). In the context of b-learning, a constructive, optimistic, differentiated and proficient approach seems to require teachers with a highly resilient sense of personal and interpersonal awareness and openness to cultural change.

9.6 Final Considerations

From the presented case study it can be derived that students expressed, in general, a positive attitude towards the use of LMS Moodle, and the b-learning courses appear to ensure contextual-specific needs due to their inherent openness and flexibility. On the other hand, results point out the importance and need to create supportive environments for a more comprehensive blended structural design (e.g., based on techno-pedagogical skills) (Bates and Sangrà 2011; Sarirete et al. 2008), in order to harmoniously improve and sustain the learning processes and institutional contexts.

From the performance of the MCA in the case studies of Chaps. 8 and 9, it seems that MCA represents a useful technique to identify profiles and their interdependencies, and to show the structural complexity of data from a large number of categorical variables. The application of this technique allowed identifying three distinct learners' profiles: (i) interactive learning environment-oriented, (ii) students' training-oriented and (iii) ICT teachers' beliefs-oriented. Once identified these profiles, one can adjust online instructional strategies in order to respond to their specific needs, bearing in mind that "engaged learning is a collaborative learning process in which the teacher and student are partners in construction knowledge" (Conrad and Donaldson 2010, p. 8). Under this complex and multifaceted scenario, the evolution and understanding of theory and practice of truly interactive, adaptable, and co-participative b-learning environments seems to be able to guarantee interpersonal engagement, promoting and cultivating a proficient community-centered practice approach.

Moreover, the mixed method (qualitative and quantitative) adopted in both-Chaps. 8 and 9, allowed for approaching generalizing and understanding ideas. The qualitative data drawn from the teachers' and students' semi-structured interviews fed into the MCA quantitative analysis, which in turn, assisted into 'tiding' them up in a way that could be then interpreted in terms of identifying the distinct teachers' and students' profiles, accordingly.

From the knowledge gained from Chaps. 8 and 9, a step further would be towards the incorporation of teachers' profiles (see Chaps. 8) in the process of enhancing the LMS environment *en route* for more effective b-learning. Nevertheless, teaching practices on students' learning lie in the sense of cause-and-effect relationships, with the teachers playing an active and direct role in the students' acquisition of knowledge (Brophy and Good 1986; Leinhardt and Smith 1985). Consequently, teachers' profiles should not be approached independently from the learners' ones, but, rather, in relation to them, under the concept of teacher's efficiency in producing desired learning outcomes to learners in a LMS-based b-learning environment, fostering the use of a variety of appropriate representational systems, examining the concept through conceptually focused and cognitively challenging tasks, and ensuring active involvement of the students within the process of knowledge construction.

In this case study, from the available total number of students that used the LMS environment, 36 were selected here to define the sample space. Perhaps the interview sample is not representative of the overall group of students at the university. In practice, however, the number of required subjects usually becomes obvious as the study progresses, as new categories, themes or explanations stop emerging from the data (data saturation) (Marshall 1996).

From an overall perspective, the current case study tries to characterize and understand the dynamic patterns of a public HEI within the LMS Moodle environment. In spite of this, the present case study addresses in-depth relevant issues on educational processes in LMS-based b-learning environments, in the specific context of higher education, aiming at a more educated, interactive and collaborative online community. In fact, students' profiles could be used to form original learning scenarios and more functional technical approaches. The mutual connection between LMS and the students' profiles supports the symbiosis between students' informal learning and the obligatory formal learning process. In this vein, concepts like *connectivism* could allow to consider particular characteristics of a more efficient LMS, such as diversity, autonomy, openness, self-organization, interactivity/connectivity for sharing knowledge (refer for example to the emerging concept of Massive Open Online Courses (MOOC) recently introduced by Downes and Siemens (McAuley et al. 2010). In this way, discovering more about how, where, when, what and with whom people can learn in large open networks could be viable.

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Chapter 10
On Modeling Users' Quality of Interaction with LMS Using Fuzzy Logic

10.1 Introduction

Politicians, educators, and investigators have been unanimous in stating that we need to design schools to teach 21st century skills (i.e., creativity, innovation, critical thinking, problem solving, communication, and collaboration); however, HEIs are paralyzed by the lack of consistent and intelligent ways to assess these skills/competences. One of the difficulties is that, usually, the current assessment instruments are based on products and not on processes, due to the intrinsic complexities in capturing detailed process data for large numbers of users. In turn, data mining technologies, signal processing, text-mining, machine learning to explore multimodal process-based learner assessments could offer a possible solution to capture/analyze massive amounts of process data of classroom online activities.

Following the aforementioned pathway, this chapter presents the fourth case study of this book, which targets the quality of learning experience within an OLE. Equipped with the knowledge of usability issues (Chap. 7), teachers' profiles (Chap. 8) and students' profiles (Chap. 9) within an OLE, it is natural to proceed to modeling approaches that shed light upon the intrinsic mechanisms of peers' interaction with the OLE. If the latter could be understood, then more intelligent LMSs could be deployed within the OLE, to enhance the quality of learning.

Quality of learning experience directly relates with the amount and the quality of interaction (QoI) and the sense of commitment to a community of inquiry and learning. Those could be achieved through the effective integration of technology, while at the same time exploiting the advantages of a traditional course that includes lectures and meetings (Garrison and Kanuka 2004). Towards this blending, designing, developing and deploying programs that are well organized, using multimedia to engage the learner by employing various intelligences, capturing the experiences and knowledge of the learners, while incorporating and promoting interactivity and training instructors to facilitate online delivery, demand a strategic decision to be made and adequate resources be made available. B-learning can address the potential shortcomings of a purely e-learning approach,

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yet only in the context of educators taking a strategic approach and planning appropriately (Wall 2012). This suggests that education providers (e.g., HEIs) should find the most appropriate blend of conventional and digital learning resources.

Determining learning behavior in electronic media, however, is a complex problem. A difficulty is that these environments are mostly used by students away from the classroom and out of sight of their educators. Without the informal monitoring that occurs in F2F teaching it is difficult for educators to know how their students are using and responding to these environments. In this line, educators have had to explore new ways of obtaining information about the learning patterns of their students. This clearly requires the development of effective methods of determining and evaluating learner's behavior in electronic environments (Hijón and Velázquez 2010), a role that is undertaken by LMSs.

The user's interaction with a LMS (e.g., Moodle) is actually realized within OLEs, which are characterized by fastness and immediacy, i.e., the ability to quickly access a vast amount of information coupled with a plurality of Web 2.0 tools (Conole et al. 2008; Redecker et al. 2009). Apparently, the efficiency of the LMS depends on how effectively the users can access its multi-faceted benefits when interacting with it. According to Wagner (1994), the interaction can be seen as the occurrence of reciprocal events that require the existence of at least two objects and two actions, and when they influence each other. Chatteur et al. (2008), also report that in OLEs is not uncommon for individuals to interact spontaneously, i.e., without being motivated and/or encouraged through interaction strategies and/or activities. In addition, Herrington et al. (2007) argue that the (un)successful learning is intrinsically dependent on the degree of interaction that takes place in a specific educational context. Collins and Berge (1996) highlighted that learners tend to combine the new knowledge acquired by interacting with content, with their prior knowledge on that subject matter. Hence, interaction can be synthesized as an active process which requires learners to do more than passively absorb information.

Oliver and McLoughlin (1997) explored the dimensions of interaction by classifying interaction activity into five parts, i.e., social (e.g., discussions of a social nature which are not directly associated with the course content), procedural (e.g., explanation on course related procedures, requirements and administrative issues), expository (e.g., demonstration of knowledge/facts without much further elaboration), explanatory (e.g., elaboration of explanation on knowledge and developed content based on learner's response) and cognitive (provision of constructive feedback and detailed commentary on course content via critical thinking which leads to knowledge development).

The QoI between learner with online content is one of the imperative factors in determining the efficacy of web-based teaching-learning towards the creation and maintenance of sustainable learning communities (Anderson et al. 2001; Kidd 2005; Lim and Lee 2007; Grant and Thornton 2007). Interaction with content is an internal dialogue of reflective thought that occurs between learner and the substance. Interaction is often triggered and supported by events in the learning

environment-on how the learner interacts with what is to be learned. For example, in an analysis of student's use of a courseware website, Peled and Rashty (1999) found out that the most popular online activities were passive and involved getting information rather than contributing. Their conclusion is that the students were very goal-oriented in their use of the Web site.

Further information can be gained from knowing when students access resources (Sheard et al. 2005). This can help educators understand student's preferred learning patterns. A study carried out by McIsaac et al. (1999) explored interactions of doctoral students with an online environment and they concluded that student interactions were goal-focused. For instance, in Hellwege et al. (1996), it was shown that students were accessing resources according to immediate need. In this way, another study (Hijón and Velázquez 2006) of this characteristic showed that the average connections to the LMS was over thirty minutes. Analysis of learner's interactions may also be used to compare learning behaviors of different groups of students. In some empiric studies made, it is highly remarkable the importance on time and dedication to the course habits (Nian-Shing and Kan-Min 2002), the connection time (Kickul and Kickul 2002) and the total number of accesses to the system (Ramos and Yudko 2008).

The aforementioned suggest the approach of user's LMS interactions from the perspective that reveals their quality, so the latter could be used to unfold the true nature of the users' attitude when interacting with the LMS within a b-learning environment. So far, works focused on QoI usually employ statistical analysis of LMS data, combined with transcripts of the discussions and exchanges of teacher and learners within the online forums, specifically investigating the dimension, depth and category of exchanges occurred (Ping et al. 2010).

Following an alternative pathway, the case study of this chapter adopts the *FuzzyQoI* model (see Sect. 6.5 and Dias and Diniz 2013) that takes into account the users' (professors' and students') interactions, as expressed through the LMS usage within a b-learning environment, and, by translating the knowledge of the experts in the field to fuzzy constructs, estimate, in a quantitative way, a normalized index of the users' QoI. The latter, then, can be used to identify user-dependent and user-independent (group-like) (dis)similarities in LMS interaction trends, correlations, distributions and dependencies with the time-period of the LMS use.

10.2 Case Study Structure

10.2.1 Experimental and Implementation Issues

The LMS Moodle data for the validation of the proposed *FuzzyQoI* model (Sect. 6.5) were drawn from a b-learning environment related to five undergraduate courses (Sport Sciences, Ergonomics, Dance, Sport Management and Psychomotor

Rehabilitation) offered by a public HEI (i.e., FMH). The users of the LMS Moodle were both professors [75 in total, 49 % male, aged from 24 to 54yrs-old (mean ± std = 47.19 ± 8.8yrs-old)] and students [1,037 in total, 45 % male, aged from 18 to 48yrs-old (mean ± std = 25.05 ± 5.9yrs-old)], all started to use LMS Moodle in the 2009/2010 academic year.

The data used in this case study correspond to a 51-week LMS Moodle usage time-period (August 26, 2009–August 18, 2010), including 610,775 interactions in total (94,288 from professors and 516,487 from students). For each LMS Moodle metric included in the category 'Action' (alone or combined with the category 'Module', see Table 6.1) logged by a user, a number from 1 to 12 was assigned, according to the correspondence of LMS Moodle metrics with the 12 input variables of FS1–FS3 (see Fig. 6.2 and Table 6.1). In order to accommodate any possible absence of users' interactions with the LMS Moodle for one day (or perhaps a couple of days) per week, the number of the daily data loggings belonging to the same category per user was summed across the duration of one week; hence, setting the latter as the analysis time-unit. In accordance to this, the input variable *TP* of FS5 (see Fig. 6.2) was corresponded to a sequence of numbers from 1 to 51, whereas the values of the input variable *ET* of FS5 (see Fig. 6.2) were kept in seconds, as they were initially formatted by the LMS Moodle archiving engine. Since the universe of discourse of all (input/output) variables of the *FuzzyQoI* scheme ranges from 0 to 1 (see, for example, the horizontal axis Fig. 6.3), all derived input variable values per week were normalized to the corresponding maximum value across the analyzed total time-period, i.e., 51 weeks, for each user. Furthermore, some distinct dates across the whole examined time-period were taken under consideration to segment the latter; these are tabulated in Table 10.1.

The resulted time-period sections (e.g., semesters, exams, interruptions) were used as landmarks to identify any possible changes in the users' interaction behavior (as expressed in the output of the *FuzzyQoI* model), correlated with a specific time-period section.

Table 10.1 The correspondence of distinct periods with the weeks of the whole examined time-period, taken under consideration for segmenting the latter. (Dias and Diniz 2013)

Distinct period		Starting week	Ending week
Academic Year 2009/2010		2	46
Semesters			
	1st	2	16
	2nd	23	38
Exams			
	1st period	18	23
	2nd period	38	46
Interruptions			
	Christmas (2009/2010)	16	18
	Carnival (2010)	24	25
	Easter (2010)	30	31

10.2.2 Analysis Tool

As already mentioned, the modeling approach and data analysis tool of this case study were based on the *FuzzyQoI* model (see Sect. 6.5 and Dias and Diniz 2013). Analytical results of its application of the LMS Moodle professors' and students' interaction data follow.

10.3 Case Study Results

10.3.1 Professors' QoI

The contour plot of Fig. 10.1 depicts the estimated output *QoI* from the FS5 (see Fig. 6.2) of the *FuzzyQoI* model for the case of professors (sorted in an ascending order according to the date of their first access to the LMS Moodle) across the examined period (51 weeks). The estimated *QoI* values lie within the range of [0.1, 0.59]. Note that in the contour plot, each point corresponds to the pair (*x*-axis: week#, *y*-axis: professor#), whereas the greyscale intensity expresses the value of the specific fuzzy output within the range of [0, 1] for the specific pair. Moreover, the lines in parallel to *y*-axis are drawn at the specific weeks that define the time-period segmentation according to Table 10.1, so to facilitate visual grouping of the results at the specific time-period sections.

As it is seen from Fig. 10.1, the professors' estimated *QoI* values are medium (around 0.50) in many cases, yet there ones where *QoI* gets lower values (<0.3) and ones with even lower values (<0.2). Moreover, there are some 'ridge'-like lines across the week axis, combined with some singularity of pairs with significant *QoI* values; there are, however, many cases where the *QoI* value is sustained significant for more than one week (e.g., located at the time periods of 18–23 and 38–46 weeks).

The derived *QoI* domain of Fig. 10.1 can serve as monitoring space of the quality of interaction for *each single* professor across the whole examined time-period, providing a means for setting an evaluation process that could activate possible metacognitive procedures towards more efficient incorporation of LMS Moodle in their activities as educators.

The plot of Fig. 10.2 shows the mean value (solid middle line) ± std (gray area) of the estimated *QoI*, averaged across the professors, revealing a *group-like* tendency of their interaction with the LMS Moodle across the examined time-period.

From the inspection of Fig. 10.2 it is clear that, as a group, teachers show a low-towards-moderate interaction (in all estimated parameters the mean value lies within [0.1, 0.2]), which dependents on the time-period segmentation (see Table 10.1). Note that the low mean values of Fig. 10.2 are mainly due to professors' time-delayed and discontinued interaction seen in Fig. 10.1, so in the

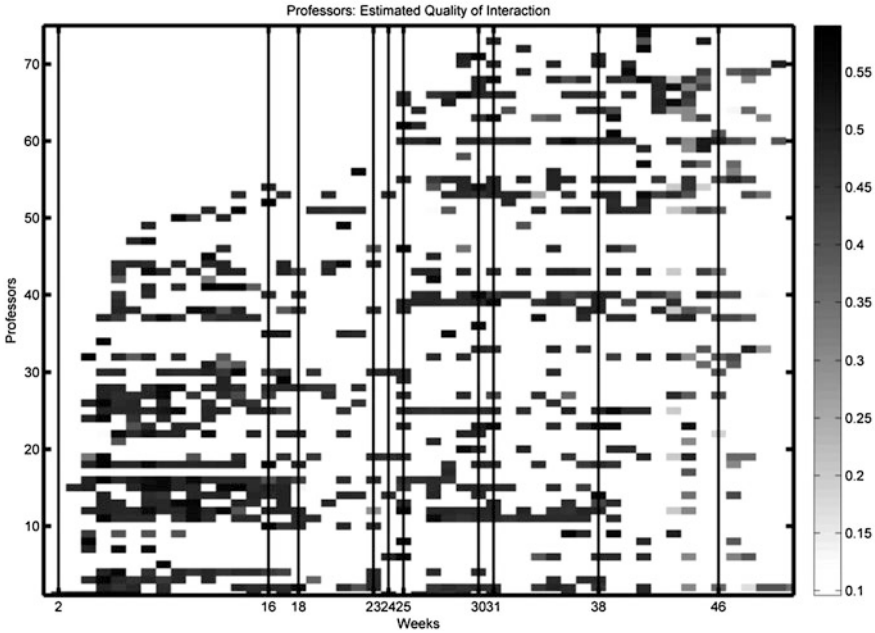

Fig. 10.1 The estimated output *QoI* from the FS5 (see Fig. 6.2) of the *FuzzyQoI* model for the case of professors across the examined time-period (51 weeks). The vertical lines denote the specific weeks that define the time-period segmentation according to Table 10.1 (Dias and Diniz 2013)

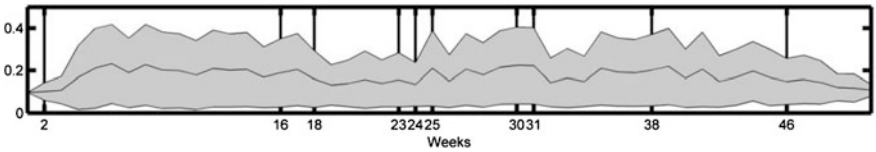

Fig. 10.2 The mean value (solid middle line) ± std (gray area) of the estimated *QoI*, averaged across the professors. The vertical lines denote the specific weeks that define the time-period segmentation according to Table 10.1 (Dias and Diniz 2013)

averaging across professors, often, the lower values dominate to the higher ones. In the estimated mean *QoI* there is, as it was expected, a noticeable increase at the beginning of the academic year (week 2) and a gradual reduction at the end of it (after week 46). Moreover, the achieved mean *QoI* after week 2 peaks around week 4 (with a simultaneous increase of the std values) and it is almost sustained at this level until the end of the first semester (week 16) and even during the Christmas period (weeks 16–18), just before the beginning of the first exams period (week 18). In the latter (weeks 18–23), the mean *QoI* is reduced, along with the corresponding std values, showing, thus, a kind of common behavior among

the professors regarding their less effective interaction with the LMS Moodle during the first exams period. This behavior, however, is then altered, with the mean *QoI* exhibiting a peak during the Carnival period (weeks 24–25), sustained high (with small fluctuations) from the beginning of the second semester (week 23) until the end of the Easter period (weeks 30–31). Then, it is reduced for a while (until week 34), increasing again up to an almost constant value until the end of the semester (week 38). At the second exams period that follows (weeks 38–46), professors exhibit a gradual decrease (with small fluctuations at the beginning of this time-period) in their mean *QoI*, which becomes more evident (with a noticeable decrease in the std values revealing a common attitude of professors) after week 46, where probably summer vacations start.

Monitoring of the alterations of the mean *QoI* and the corresponding std across the whole time-period can assist the acquisition of the dynamic underlying attitude of the professors as a group, regarding their effective interaction with the LMS Moodle. This, then, could be used as an informative parameter that could evoke initiatives towards rethinking of the value and efficiency of the LMS-based b-learning environment, both by the educators, the LMS designers and education policy makers.

10.3.2 Students' QoI

Similarly to the professors' case, the contour plot of Fig. 10.3 depicts students' estimated output *QoI* from the FS5 (see Fig. 6.2), lying within the range of [0.1, 0.59]. As it is seen from Fig. 10.3, the students' estimated *QoI* values are medium (around 0.50) in many cases, with some cases even exceeding 0.55 (e.g., the pairs of (week#5, students#5,13:14,17,19)), yet there ones where QoI gets lower values (<0.3) and ones with even lower values (<0.2). Nevertheless, there are many cases where the QoI value is sustained significant for more than one week across students, with distinct examples at the end of the first exams period (weeks 21:23) and even more at the time-period that starts after the half of the second exams period (week 43) and extends up to the middle of the summer period (week 49).

Similarly to the case of professors, the derived *QoI* domain of Fig. 10.3 can also serve as monitoring space of the quality of interaction for each single student across the whole examined time-period, initiating evaluation processes that, in turn, could promote possible metacognitive procedures towards more efficient incorporation of the LMS Moodle in their activities as learners.

The *group-like* tendency of students' interaction with the LMS Moodle across the examined time-period is illustrated in Fig. 10.4, which shows the mean value (solid middle line) ± std (gray area) of the estimated *QoI*, averaged across the students. From the latter it is clear that, as a group, students show a low-towards-moderate interaction (in all estimated parameters the mean value lies within [0.1, 0.2]), which dependents on the time-period segmentation (see Table 10.1). Note that the low mean values of Fig. 10.4 are mainly due to students' time-delayed and merely

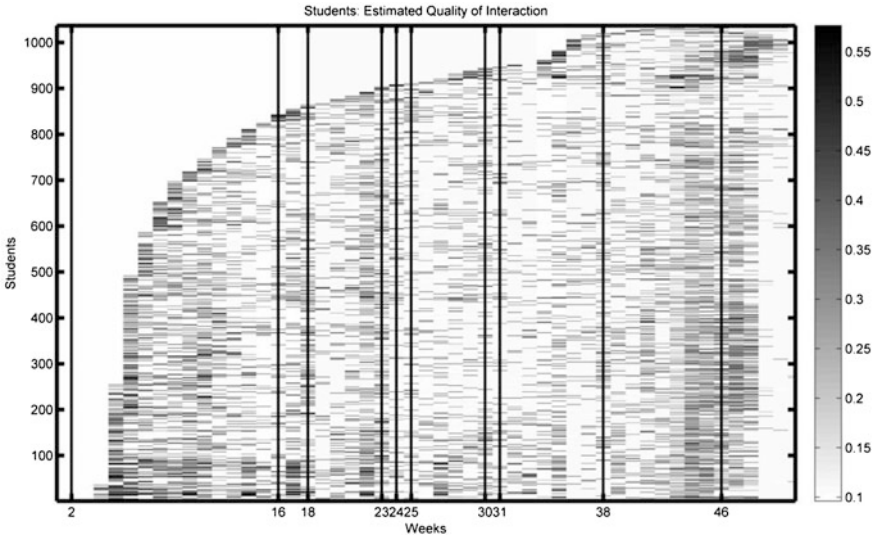

Fig. 10.3 The estimated output *QoI* from the FS5 (see Fig. 6.2) of the *FuzzyQoI* model for the case of students across the examined time-period (51 weeks). The vertical lines denote the specific weeks that define the time-period segmentation according to Table 10.1 (Dias and Diniz 2013)

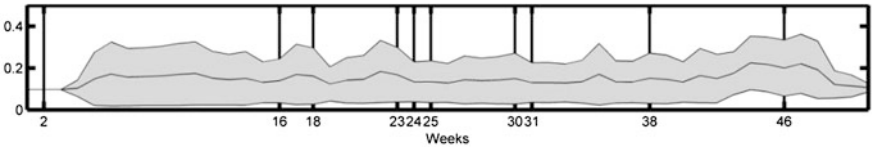

Fig. 10.4 The mean value (solid middle line) ± std (*gray area*) of the estimated *QoI*, averaged across the students. The vertical lines denote the specific weeks that define the time-period segmentation according to Table 10.1 (Dias and Diniz 2013)

discontinued interaction seen in Fig. 10.3, so in the averaging across students, frequently, the lower values dominate to the higher ones.

In the estimated mean *QoI* there is a noticeable increase just after the beginning of the academic year (week 4) and, unexpectedly, a gradual reduction at the mid of the summer period (after week 49) and not at the end of the academic year (week 46). Following the curve of the achieved mean *QoI*, after week 4 it peaks around week 7 (with a simultaneous increase of the std values) and it is almost sustained at this level until the end of the first semester (week 16) at which is then reduced. During the Christmas period that follows (weeks 16–18) it exhibits another peak, showing that students interacted more efficiently with the LMS Moodle within the holiday period. At the beginning of the first exams period (week 18), the mean *QoI* is reduced, along with the corresponding std values, showing, thus, a kind of

common behavior among the students regarding their less effective interaction with the LMS Moodle when the first exams period started. This behavior, however, is then altered, with the mean *QoI* exhibiting a peak close to the end of the first exams period (week 22), showing that, probably, the exams gradually motivated the students to increase their effective interaction with the LMS Moodle. During the Carnival period that follows (weeks 24–25) the mean *QoI* reduces again and it is sustained almost constant (with small fluctuations) until the two thirds of the second semester (week 35), where it exhibits a local peak, possibly due to the students' preparation for the second exams period that follows. In the latter, the same pattern of the mean *QoI* noticed at the first exams period is also repeated here, yet with a more intensive way, i.e., there is a gradual increase towards higher values at the end of the second exams period (week 46), which is also extended for 3 weeks further until week 49. This behavior is totally different than the inactive one seen in the professors' case after week 46, showing a kind of echoed vigilance interacting with the LMS Moodle stemmed from the second exams period. After week 49, the mean *QoI* quickly declines to a low value (along with the corresponding std values, revealing a common attitude of students) until the end of the examined time-period (week 51).

From the above it is clear that the dynamic nature of the students' attitude as a group, regarding their effective interaction with the LMS Moodle, is effectively monitored through the alterations of the mean *QoI* and the corresponding std across the whole time-period. Based on the latter, an overview of the students' interaction trend as LMS-mediated learners is feasible; this, then, could be correlated with the professors' one, as it is described in the succeeding subsection.

10.3.3 Correlation Analysis Results

Stemming from the results of Figs. 10.2 and 10.4, a correlation analysis that explored any possible association between the mean values of the estimated *FuzzyQoI* model variables, i.e., View (V), Addition (AD), Alteration (AL), Action (AC) and QoI (see Sect. 6.5), from professors' and students' classes for the examined time-period was carried out.

In particular, the correlation coefficient r accompanied with the probability of false alarm p, which denotes the statistical significance of the estimates of r, were estimated for:

- the total time-period (weeks 1–51);
- the academic year (weeks 2–46);
- the 1st semester (weeks 2–16);
- the 2nd semester (weeks 23–38);
- the 1st exams period (weeks 18–23); and
- the 2nd exams period (weeks 38–46).

The derived results are tabulated in Table 10.2 (values in bold denote statistically significant estimates of r ($p<0.05$)). From the latter it is apparent that the time-period segmentation affects the correlation between the average *QoI* from professors and students, i.e., the correlation of their behaviour as a group. In particular, when no time-period segmentation is adopted, all estimated *FuzzyQoI* model variables exhibit statistically significant r values between the two classes (professors and students), ranging from 0.3640 (*QoI*) up to 0.7209 (AL). The same trend holds when the academic year is considered, yet with a reduction in the r values in all variables, ranging from 0.3019 (*QoI*) up to 0.6385 (AL). This situation is reversed when the 1st semester is only considered, as there is a significant increase in the r values in all variables, ranging from 0.6790 (AD) up to 0.8289 (*QoI*). When considering the 2nd semester, however, there is only one statistically significant estimate of r that corresponds to AC (0.5456), whereas, there is no statistically significant estimate of r for any variable during the 1st exams period. The latter, nevertheless, is altered during the 2nd exams period, where three variables exhibit strong r values ranging from 0.6799 (AD) up to 0.8523 (AC).

The aforementioned correlation results show that professors and students exhibited, in general, a similar pattern in their interaction with the LMS Moodle, especially during the 1st semester, where their mean *QoI* values are strongly correlated ($r = 0.8289$). This could probably be explained by the fact that, for both groups, this was the first time (year 2009) they were involved in the environment of b-learning via the LMS Moodle. As they were getting more acquainted with the

Table 10.2 The correlation coefficient of the mean values of the estimated *FuzzyQoI* model variables along with the probability of false alarm (r, p) between professors' and students' classes for the examined time-period (in weeks). Values in bold denote statistically significant estimates of r ($p<0.05$). (Dias and Diniz 2013)

FuzzyQoI model estimated variable[a]	(r, p)					
	Examined period (weeks)[b]					
	Total (1–51)	Academic year (2–46)	1st Semester (2–16)	2nd Semester (23–38)	1st Exams Period (18–23)	2nd Exams Period (38–46)
View (*V*)	(**0.4947**, **0.0002**)	(**0.4277**, **0.0034**)	(**0.7022**, **0.0035**)	(0.3976, 0.1272)	(0.6196, 0.1896)	(0.4691, 0.2027)
Addition (*AD*)	(**0.5559**, **0.00002**)	(**0.5346**, **0.0002**)	(**0.6790**, **0.0054**)	(0.2679, 0.3158)	(0.6725, 0.1433)	(**0.6799**, **0.0439**)
Alteration (*AL*)	(**0.720**, **2.4×10^{-9}**)	(**0.6385**, **2.3×10^{-6}**)	(**0.6876**, **0.0046**)	(0.4776, 0.0613)	(−0.1575, 0.7658)	(**0.7731**, **0.0146**)
Action (*AC*)	(**0.6927**, **1.7×10^{-8}**)	(**0.6268**, **4×10^{-6}**)	(**0.7791**, **0.0006**)	(**0.5456**, **0.0288**)	(0.3295, 0.5236)	(**0.8523**, **0.0035**)
Quality of Interaction (*QoI*)	(**0.3640**, **0.0086**)	(**0.3019**, **0.0438**)	(**0.8289**, **0.0001**)	(0.2648, 0.3216)	(0.3807, 0.4566)	(−0.1361, 0.7270)

[a] Mean value across users

[b] Interruptions: Christmas (weeks 16–18); Carnival (weeks 24–25); Easter (weeks 30–31)

latter, however, they started deviating from this common pattern, causing totally uncorrelated attitude during the 1st exams period. This trend was almost sustained similar during the 2nd semester, yet altered during the 2nd exams period, implying the existence of a kind of pattern convergence, yet not in the one of the mean *QoIs*. This could probably be the result of the accumulation of "newcomers" in both groups at that period, mimicking, in a way, the behavior of the "old hands" users during the 1st semester.

In order to further elaborate on the association in the delay pattern between professors and students, the correlation coefficient between the two delay curves, derived by following the initial nonzero *QoI* value for each group-user in the domain of Fig. 10.1 (professors' delay curve) and Fig. 10.3 (students' delay curve), was estimated. The latter was found equal to $r = 0.9571 (p = 5 \times 10^{-28})$, showing a highly significant correlation in the delay pattern between professors and students. This could be explained as a kind of mirroring between professors and students, as the former act as the initial input to the LMS Moodle that then energizes the latter to respond.

Finally, to examine any possible delays in the derived *QoIs* (matrix) and mean *QoI* curves (vector) between professors and students, 2-D and 1-D cross-correlation analysis took place, respectively. In the latter, the two matrices (vectors) are compared about their similarity via a lag-shifting process and the time lag that corresponds to the maximum of the derived cross-correlation denotes the time delay between the cross-correlated matrices/vectors. Here, the time-lag resolution was one week and the horizontal shifting process was realized in both directions (positive/negative lags). The resulted 2-D and 1-D cross-correlations, i.e., $CC^{2D}(i,j)$ and $CC^{1D}(i)$ with $0 \leq i < 101 (= 51 + 51 - 1)$ and $0 \leq j < 1111 (= 1037 + 75 - 1)$, are depicted in Figs. 10.5 (a) and (b), respectively.

As it is clear from both subfigures, the maximum values in the overwhelming majority of $CC^{2D}(i,j)$ and the one in $CC^{1D}(i)$ lie at zero-lag, indicating absence of any delay between the derived *QoIs* and mean *QoI* curves between professors and students. This finding reveals almost an immediate reflective response of the students to the professors' stimuli at the LMS Moodle space.

10.4 Discussion

As described in the previous section, the proposed *FuzzyQoI* model was validated on data drawn from LMS Moodle. The latter provides many communication tools, facilitates the creation and administration of learning objects, allows management of user data, fosters usability, and exhibits adaptation capabilities (Graf 2007). From this point of view, and taking into consideration the richness of the available information sources within the examined b-learning environment, one should expect quite higher *QoI* values than those estimated by the *FuzzyQoI* model, both

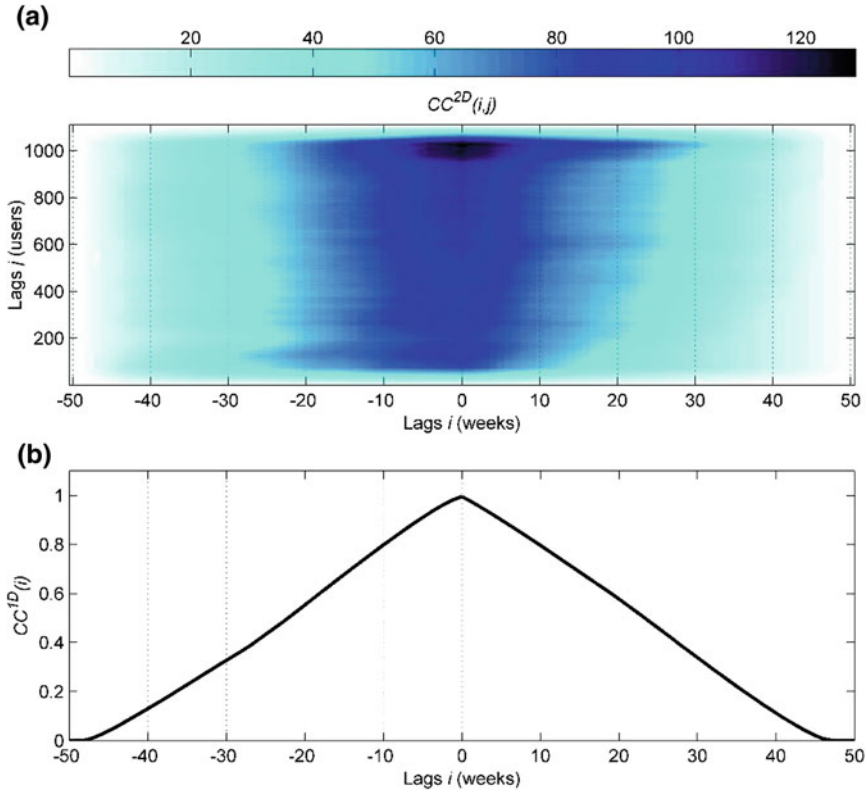

Fig. 10.5 (**a**) 2-D cross-correlation $CC^{2D}(i,j)$ between the derived *QoI*s from professors and students. (**b**) 1-D cross-correlation $CC^{1D}(j)$ between the derived mean *QoI* curves from professors and students. The time-lags range within $0 \leq i < 101 (= 51 + 51 - 1)$, yet with i rearranged to $-50:0:50$ so to clearly denote the shifting in both directions (positive/negative lags), and $0 \leq j < 1111 (= 1037 + 75 - 1)$. The location of the maximum value at zero-lag is noticeable in both subfigures

for professors and students. This could be initially considered as a kind of bias embedded within the proposed model towards medium/low *QoI* values.

Nevertheless, it is clearly due to the effect on both professors and students of the process of transition from the traditional course learning to a b-learning, as the data that were drawn from the LMS Moodle and analyzed by the *FuzzyQoI* model correspond to the first year of use (2009), both by professors and students.

Naturally, as with any new learning modality there are many issues which need to be addressed when considering a move of an entire institution's curriculum in this direction, i.e., from shallow systems compliance to deep pedagogical change. Issues like course format changes, communicating the change, training faculty, common course shell, workload changes, cultural impacts, communication and evaluation of the transition, clearly affect the effectiveness of the users' interaction

within this new context (Singleton 2012). Nevertheless, this fact could be considered as a kind of difficult benchmark case for the proposed model to respond. The results presented in the previous section have shown that this effect was clearly captured by the *FuzzyQoI* model, not only as a general trend from a macroscopic view, but also as a dynamic phenomenon that evolved during the whole time-period, affected by the specific characteristics of each time-period segments, justifying the ability of the *FuzzyQoI* model to capture *QoI* changes even at a microscopic level of resolution, as well.

At the current stage, LMS provides the same course for each learner. Learners then have the possibility to use the provided learning material in different ways. According to Felder and Silverman (1988), learners might have difficulties in learning if their learning style is not supported by the teaching environment. As a remedy to this, they recommended to provide courses with many different features which support different learning styles rather than providing courses that suit only one learning style. This is also supported by the b-learning environment. Although there are conflictive results about the effectiveness of incorporating learning styles in traditional and online education and the impact on performance and/or behavior (Jonassen and Grabowski 1993; Coffield et al. 2004), adaptation of the LMS courses to the individual learning styles of learners can be useful (Graf 2007). In addition, by enhancing LMSs with adaptivity, teachers can continue holding their courses in LMSs and therefore, taking all advantages of LMSs. Extending this perspective here, the intermediate estimated fuzzy outputs and the final *QoI* output of the proposed *FuzzyQoI* model can be used as indicators twofold, so they that can: (i) serve as the basis for the generation process of adaptation features for the LMS (system's response) and (ii) evoke metacognitive procedures within the users, so they could improve their quality of interaction with the LMS (user's response).

Turning into the design of the *FuzzyQoI* model, it should be noted that a unified approach across professors and students was adopted; that is, the same *FuzzyQoI* model was considered both for professors' and students' cases. Rather that designing two separate models, the unified *FuzzyQoI* one absorbs any essential differences in the LMS Moodle interaction between the professors and students within the definition of its fuzzy rules. In this way, within the total number of the latter (600) across all FSs of the *FuzzyQoI* model, all most common possible cases that could be differentiated between the LMS Moodle interaction of professors and of students are included. Moreover, the nature of the fuzzy logic itself allows for the independent firing (or not) of a fuzzy rule, according to the current value presented to the model input(s); hence, any differentiation in the interaction attitude between the two user groups is easily reflected on the activation (or not) of the proper fuzzy rule(s). This design makes the application of the *FuzzyQoI* model easier in practice, for example to be embedded as a module within the LMS structure, and reduces the computational burden by avoiding redundant repetition in its structural components (e.g., FISs, see Fig. 6.2).

The potentiality of the *FuzzyQoI* model to efficiently explore behavioral aspects of professors and students as they interact with the LMS Moodle within a

b-learning context is further described in the recent work of Dias and Diniz (2013). In the latter, specific aspects and more detailed analysis of the individual behaviors or the group trends identified via the estimated *QoI*, both for professors and students, are provided.

10.5 From the Case Study Paradigms to Personalization

The case study of this chapter completes the circle of the explicit implementation paradigms exemplified in this book, acting as a mediator for exploring the intrinsic characteristics that should be taken into account in the shifting course from LMS to *i*LMS.

Clearly, the past decade has seen enormous growth in the use of LMSs in HEIs, providing the potential for rich learning environments built on social constructivist theories under the concept of b-learning. An essential factor, however, in determining the efficacy of online teaching learning towards the creation and preservation of sustainable learning communities is the users' QoI with LMSs; yet, in many cases, QoI has not been properly acquired, mainly, due to its inherent qualitative character. To remedy the latter, the *FuzzyQoI* model described in this chapter has shown significant potential to:

- handle a multitude of variables and inference upon them, furnishing us with a quantitative approach to evaluate the quality of interaction, both in professors' and students' case; and
- function as a means for better understanding and explaining the nature of underlying aspects, which influence the construction of users' interaction behavior under the LMS-based b-learning approach.

The exploratory trajectory followed through the case studies of Part III, revealed noticeable aspects within the OLE, which all are influenced by the human behavior characteristics. OLE usability, profiles and interaction issues holistically relate with the human factor. Combined with the boosting of the Internet metamorphosis to an increasingly social tool, the need for online education that efficiently incorporates users' characteristics, evolving social needs and expectations becomes apparent. This, really, could transform the perception of the LMS to a more intelligent tool that functions in a more "personalized" way.

In typical LMS, however, the possibilities of personalization are limited. For example, a learner receives "success" to his/her special courses or classes. A deeper differentiation of instruction or learning materials or even personalization is related to the teacher and his creative ideas, but very seldom implemented in a LMS. Nevertheless, personalization plays a bigger role in other concepts; for example, personalization in e-learning is traditionally related to so-called "intelligent tutor systems". Especially in the traditions of artificial intelligence (AI), approaches were developed to "personalize" and "adapt" learning content to the learner's needs with the usage of expert systems. Technological solutions were

developed in the fields of intelligent tutoring technologies or adaptive hypermedia technologies (e.g., the approach of "instructional design" is based on the idea of the possibility to support learning in well-dosed, sequenced instruction bits).

Furthermore, in Web-based trainings these instructions are automatically adapted in relation to prior learning, learning styles or learners' preferences. Particularly, in the domain of AI the possibility of automated "content personalization" is considered to be an automatic adaptation of the learning content to the learner's profile (facilitated by some intelligent reasoning). So-called "intelligent tutors" were built to support learning (Devedižić 2006):

> The server should appear to act as an intelligent tutor both with domain and pedagogical knowledge to conduct a learning session. It should use a presentation planner to select, prepare, and adapt the domain material to show to the student. It also must gradually build the student model during his session, in order to keep track of the student's actions and learning progress, detect and correct his/her errors and misconceptions, and possibly redirect the session accordingly (p. 32).

Within typical LMS, personalization plays a lesser role. With the introduction of the Shareable Content Object Reference Model (SCORM) standardization (SCORM 2004 Edition), the first attempt to personalization in LMS was undertaken. This enables the LMS to guide a learner through a pre-defined learning process. Users have to achieve a certain percentage of a test in order to access the next level. Having a closer look at this type of personalization, it becomes apparent that this only leads to an even more rigid corset of pre-defined learning process. Unlike to the latter, "personalization" should focus on activities and possibilities to arrange structure, tools, (external) aggregated materials, look-and-feel and so on. Placed within the b-learning context, personalization means, to get information about learning opportunities and content from multiple communities and services fitting to the learner's interest.

Consequently, towards the *i*LMS, the main challenge will be the integration of different learning settings, different learner groups and different sources, along with the challenge to provide a dynamic and flexible interface to set up and maintain the list of external resources. Tin Can API, which is commonly referred to as "The Experience API" or "Next Generation SCORM" and allows software clients to read and write experiential data in the form of "statement" objects, could contribute to this field, providing several new capabilities compared to SCORM, like team-based e-learning, tracking of real-world performance, taking e-learning outside of the web browser, fostering e-learning in native mobile applications, providing more control over learning content (Tillett 2012).

Talking about personalization, the problem becomes crucial when authors want to provide materials, which should support different users in there different phases of the learning process. The task, thus, is to find a (technological and procedural) solution in order to support the learners effectively. The knowledge society demands competencies and skills that require innovative educational practices based on open sharing and the evaluation of ideas, fostering creativity and teamwork among the learners. The vast number of tools, supporting collaboration

on the Web is an indicator that social software tools are not only a flash in the pan, but lead to a new notion of learning and a measure for sustainable competence development. Towards such endeavor, ideas such as semantic analysis of learning activities, tagging opportunities with a focus on appropriateness for learning, visualization of communities and persons with similar (learning) interests, new approaches to content and network analysis, and a technical integration of different LMS, should be considered.

Nevertheless, it is important to always have in mind that the reality of learning and educational practice is not only a technical question. The challenge for educational practice is to develop, realize and establish new approaches for learning and didactical concepts that always take into account the human factor. In this trace, issues like *inclusiveness* and *affectiveness* within the OLE are quite important; thus, they are examined in the subsequent chapters.

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Chapter 11
From Blended to Inclusive Learning Environment

11.1 Introduction

In HE, technology may be either used to re-enforce the prevailing practices, such as lectures, or it may be used to transform and disrupt those practices. Although, ICTs have provided a potential for change, allowing the development of comprehensive approaches regarding teaching and learning, there is still insufficient knowledge regarding best practices in HEI, mainly concerning the use of OLEs (e.g. Moodle platform) and communication tools (Redecker et al. 2009), in general. Additionally, research evidence suggests that the open source platform Moodle, as an effective LMS, is able to be adapted to different needs and pedagogical contexts (Graf and List 2005). On the other hand, Fisseller and Bühler (2007) have emphasized that the use of online learning activities raises problems for students with disabilities in the context of HE; nevertheless, they have also argued that social computing applications might serve to support and facilitate accessibility in three inclusive ways, namely:

- with the creation of a central interface personalized to each individual's needs, so the provision of information accessed by different networks/services becomes possible;
- with the integration of standards for accessibility in the design of social computing services, facilitating the creation of accessible content to supporting accessible authoring practices; and
- with the presence of students with disabilities on LMS and by fostering of their interaction, collaboration and communication with other students, as a means to raise awareness of their needs.

Thus, e-teachers, in order to recognize strategies to potentiate inclusive learning, perhaps should identify the needs/preferences of each e-learner, but also understand that effective learning requires an active co-construction/open negotiation of knowledge.

S. B. Dias et al., *Towards an Intelligent Learning Management System Under Blended Learning*, Intelligent Systems Reference Library 59, DOI: 10.1007/978-3-319-02078-5_11,

11.1.1 Accessibility in LMS Moodle

B-learning, holistically speaking, can be understood as a combination of traditional F2F and online learning, which openly expresses that teaching-learning process, occurs in both formats—classroom and online. In turn, mixed learning modes, commonly labeled hybrid, flexible, blended or sandwich learning, can represent simple or complex scenarios, depending on the users' understanding. In other words, "Blended learning describes learning activities that involve a systemic combination of co-present (face-to-face) interactions and technologically-mediated interactions between students, teachers and learning resources" (Bliuc et al. 2007, p. 234). Additionally, some relevant explanations behind the common use of b-learning scenarios have been emphasized, namely: pedagogical richness, access to knowledge, social interaction, personal agency, cost-effectiveness, and ease of revision (Osguthorpe and Graham 2003).

To facilitate the realization of b-learning in practice, flexible and adaptable CMS are required. LMS Moodle platform can be seen as such example, since it is a universal well-known LMS that supports b-learning (Aberdour 2007), which belongs to the kind of LMS that is intentionally built on a particular pedagogical strategy (e.g., behaviorism, cognitivism, constructivism, connectivism), allowing management of user data, usability issues, and exhibits adaptation capabilities (Graf 2007).

On the one hand, to implement and develop an inclusive CMS, two major key issues should be addressed, i.e., personalization and accessibility (see also Sect. 10.5). On the other hand, to make the approach interoperable and reusable, it must be based on open software applications/options. Accordingly, at a step further, in the HE context, inclusive/adaptive learning has been addressed in a wide variety of European projects that blend a wide variety of concepts, such as LMS, educational standards, Web accessibility, and adaptable e-learning (Boticario and Santos 2008; Boticario et al. 2012). Some of these initiatives started to link the gap between inclusive/adaptive learning systems and LMS developments; however, all these are still in the exploration/research stage (pilot results), not covering yet, in this way, all personalization and accessibility issues in actual practice.

In any case, considering a holistic approach to reach accessible b-learning there is a need to offer accessible learning experiences, and not necessarily an accessible b-learning experience (Kelly et al. 2005).

11.1.2 Main Purpose

The main purpose of this chapter is to discuss about some technical potentialities of a LMS Moodle towards an inclusive b-learning environment. In other words: *What instructional* tools *could be incorporated in* LMS Moodle *towards an inclusive b-learning environment?* From blended to inclusive learning viewpoint,

an inclusive and online component can be considered as an extension of the F2F component, aiming at overcoming time–space boundaries and at meeting some of the users' (teachers and students) needs, fostering further the accessibility within the learning environment for students with disabilities or learning difficulties. This, naturally, could be based upon the already identified and described main features of the CMS, implemented in LMS Moodle, from the viewpoint of the teachers and students (Chaps. 7–10).

11.2 Inclusivity in LMS Moodle

Educational systems and HEI working together could be strategically guided to influence society. In this sense, a main concern for institutions should be to understand the real meaning of individual's multiple (sociocultural) identities, embedding the sound of equality and diversity issues (particularly at a time when HEI face increased diversity in the students' population). In addition, the impact of globalization from the combined perspectives of the different dimensions of e-community and e-identity may justify innovative methodologies in the design, implementation and development of the teaching-learning process (Wenger 1998). Unfortunately, in HEI, it is not so easy to identify practices that respond to students' special needs; however, in order to get relevant improvements in the educational process it seems clear that the most innovative changes should embrace inclusive and universal principles to develop new or improved methods of e-teaching and e-assessment, which appear to simultaneously require a generous mental effort (Clark 2003).

In Chaps. 7–10 of the present book, an effort to identify the OLE characteristics that relate with the users' attitude (i.e., usability, profiles, quality of interaction) and their needs has been presented, revealing a clear diversity and heterogeneity in users' profiles (directly) and courses (indirectly). Stemming from these, the LMS Moodle can easily be extended to improve its components features and, simultaneously, deal with accessibility issues, such as alternative media for text, audio or image contents, in order to intelligently and dynamically adapt its user-interface to all heterogeneity of users (including students with disabilities or learning difficulties). An example of effort towards such direction is the integration of the EU4ALL framework (www.eu4all-project.eu/).

More specifically, the focus on teachers' technological training seems to play a key role in supporting learners to access online learning opportunities in a proactive and personalized way. Also, it seems important to remember that technology and teaching-learning applications do not of themselves immediately solve inclusive learning. On the other hand, from a holistic perspective, b-learning can really have positive impacts for both teachers and students, particularly in making accessible, flexible and encouraging more independent learning (Bonk and Reynolds 1997; Coombs 2010).

Apparently, towards an inclusive b-learning environment, a set of mediators is also necessary to assist the management of the interactions of the users with the LMS. To this end, among others, interactive tools, interoperability/linkability issues, educational standards (e.g., SCORM, Tin Can API), multi-modal resources, instructional differentiation, assessment/feedback resources must be incorporated in the LMS Moodle to support different types of users with diverse needs.

If we consider the users' profiles described in the previous chapters (8 and 9) as an additional source of information, then optimization processes can take place into the LMS Moodle and, by affecting some structural elements, the accessibility of the outputted b-learning to the receivers (teachers and students) can be increased. This vision is schematically presented in Fig. 11.1, where the depicted diagram shows an ordinary LMS with its inputs and output, blended with additional branches (represented by the dashed squares) that control the LMS Moodle output (inclusive b-learning).

An inclusive b-learning environment can truly represent an opportunity to enhance an institution position, expand access to institution educational offerings, facilitate social dynamics, and also reduce operating costs. According to Wenger (1998):

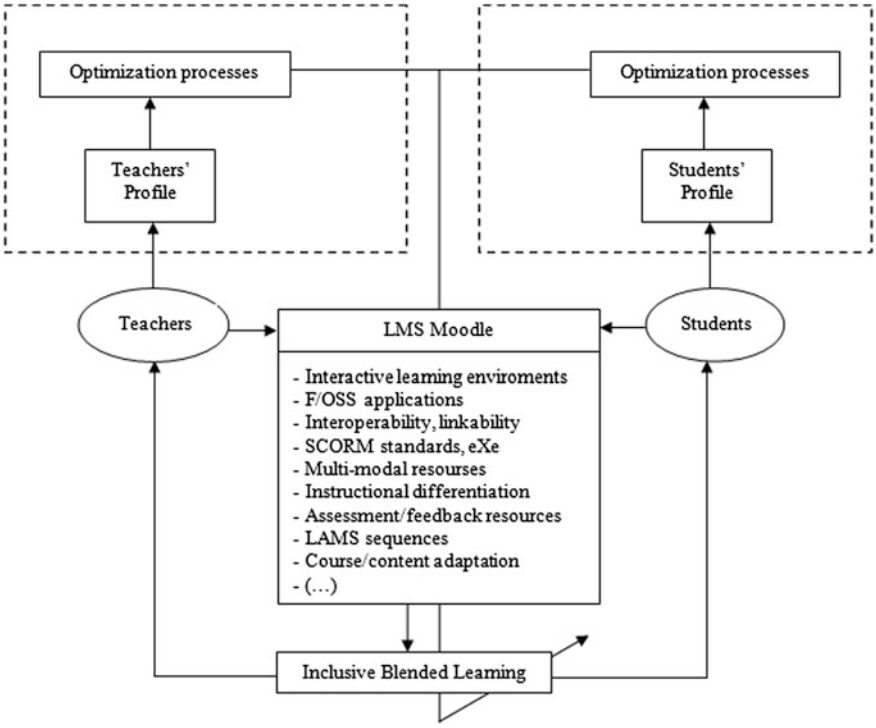

Fig. 11.1 Graphical representation of the functioning of the LMS Moodle based on inclusive b-learning environment

> (…) focusing on identity brings to the fore the issues of non-participation as well as participation, and of exclusion as well as inclusion. Our identity includes our ability and our inability to shape the meanings that define our communities and our forms of belonging (p. 145).

Additionally, with the development and implementation of interoperability standards, it will be easier to find and select content for individual students; nevertheless, it is vital that CMS administrators follow the WWW accessibility guidelines and interoperability principles, in order to represent a remarkable advantage to students with disabilities and a real motion to equal learning opportunities for all students, and, as a result, to try to guarantee universal inclusion practices (Peacock et al. 2002; Coombs 2010).

In other words, the administrators also need to be aware of the whole landscape about what, why and how decisions are made about the inclusive and accessible technologies.

11.3 A Framework for Embedding Inclusive OLEs

From a more technical point of view, quite recently, the Moodle 2.5 version has considered various minor usability and accessibility improvements (e.g., badges and bootstraps), from simplified forms to more navigable course pages. Among other themes, *Moodlebook*, a kind of "Facebook" theme/style for Moodle, seems to guarantee an easy/clear navigation (incorporating e.g., dropdowns from the main menu bar) and an appealing interface, following a three-column format (Fig. 11.2). In general, it is based on the *decaf* fluid-width theme for LMS Moodle, improving usability features, by shifting setting blocks to top of the page, so called "Moodle awesome bar" (https://moodle.org).

Additionally, the integration of the EU4ALL framework in the LMS Moodle (see red square in Fig. 11.2), can be seen as an example of holistic approach for embedding inclusive environments, where the curriculum, learning activities, services/resources take into account the diversity of individual needs/preferences of all students, including those with disabilities, i.e., focusing on personalized/individualized learning experiences.

More specifically, Moodle administrators and/or the users with the capability to "Configure EU4ALL plugin settings" are allowed to configure the EU4ALL Moodle plugin. For instance, using the EU4ALL framework on a course, e-professors/e-moderators can add a resource of the type "Adaptable" (Fig. 11.3) and their alternatives, in a simple way. However, this resource does not provide content *per se*; it is a kind of necessary abstraction to access the alternatives of a resource. From this perspective, to insert an "Adaptable" resource, the e-moderators of a course simply "Add a resource X" and select "Adaptable" (Fig. 11.3).

On the other hand, the e-student/e-learner should quickly update his/her accessibility preferences, so that the system can provide the precise adaptations, based on the user needs/preferences (Fig. 11.4).

Fig. 11.2 The Moodlebook interface with the EU4ALL framework integration (red square)

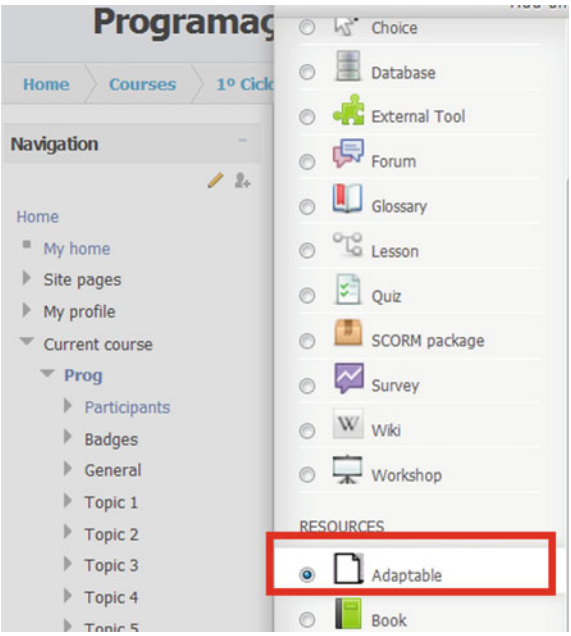

Fig. 11.3 The online educational "Adaptable" resource generated by the EU4ALL framework

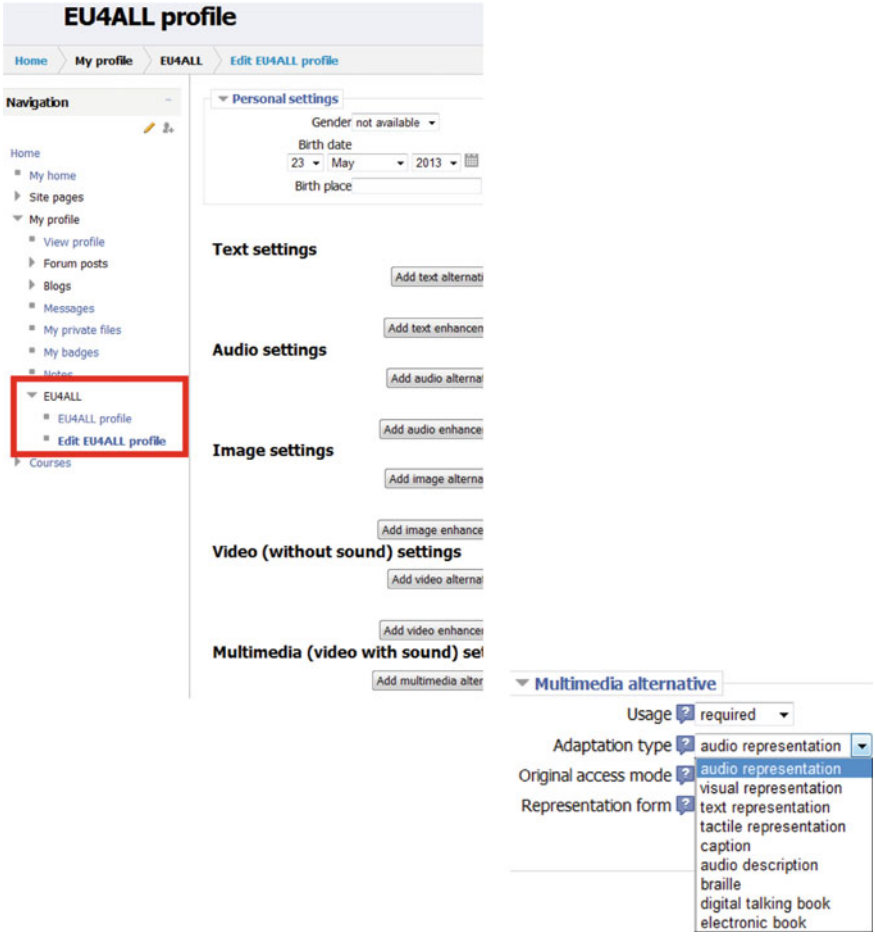

Fig. 11.4 The EU4ALL accessibility preferences, EU4ALL profile, and multimedia setting

Nevertheless, it is important to underline that within the EU4ALL environment, two e-learners do not demonstrate the same necessities, even if they have the similar disability, i.e., their needs will always be individual.

11.4 An Open Resource in B-Learning

Fortunately, nowadays, there are a number of perspectives/frameworks on accessibility and learning design, e.g., Learning Activity Management System (LAMS), Design for All (DfA), Universal Design for Learning (UDL), Universal

Instructional Design (UID), IMS Learning Design (IMS-LD), which are possible to be adopted within educational contexts. In general, online educational content should present the following characteristics (Varlamis and Apostolakis 2006):

- *interoperability*: the content from multiple providers can be easily disseminated amongst consumers and a multitude of systems;
- *reusability*: content and code can be assembled, disassembled, and re-used quickly and easily;
- *manageability*: the system can track the appropriate information about the learner and the content;
- *accessibility*: the learner can access to the appropriate content at the appropriate time on the appropriate device. Content warehouses can be developed and become available to amateurs or professionals that use any application based on the common standards;
- *durability*: the content is produced once and transplanted many times in different platforms with minimum effort; and
- *scalability*: learning technologies can be expanded in functionality, in order to serve broader populations and organizational purposes.

In fact, the Internet, based on several digital technologies, seems to be well-suited for open, flexible and blended learning environments; however, Khan (2005) noted that:

> Designing open, flexible, and distributed e-learning systems for globally diverse learners is challenging; however, as more and more institutions offer e-learning to students worldwide, we will become more knowledgeable about what works and what does not work (p. 150).

From this perspective, designing and providing instruction and training on the Internet still requires considerable analysis and research, combined with an understanding of the online resources and the ways in which (universal) instructional design principles can be applied to explore the potential of the Internet.

Among others, the e-learning XHTML editor, also called eXelearning (eXe) authoring environment, is commonly used as a helper of e-tutors on the design, develop and publish e-learning objects. Based on the concept of instructional devices (iDevices) as small elements to manage the presentation of learning materials, this software offers a choice of templates that enable to incorporate text, images, sound, video, and interactive components (http://exelearning.org/, see Fig. 11.5). In fact, the eXe object can be imported into a variety of LMS (e.g., Moodle). From a pedagogical perspective, Fig. 11.6 represents a SCORM content package generated by eXe in LMS Moodle, showing a set of navigable Web pages, used as formative assessment for learners interacting with content.

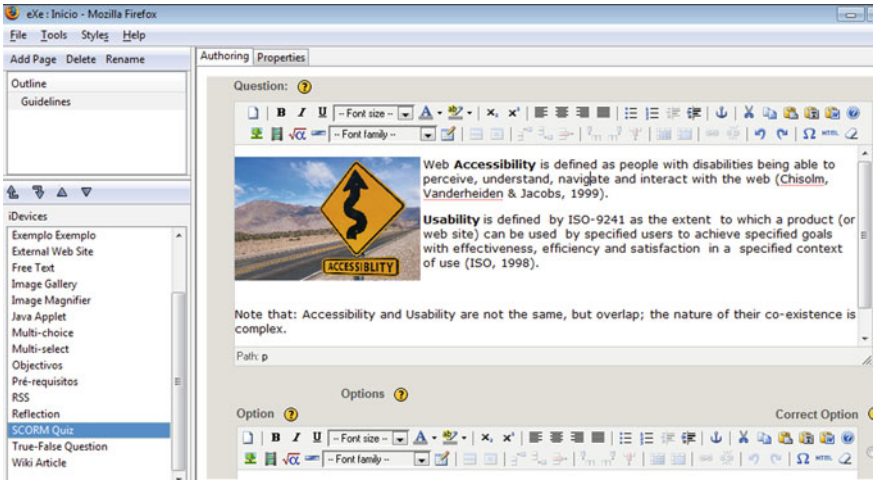

Fig. 11.5 eXe tool interface to create educational content using SCORM format

Exploring all these practical directions, it is important to underline that inclusive b-learning environments should not only be meaningful to learners, but also be meaningful to all stakeholder including instructors, staff, and the institution, involving a pro-efficient process of planning, selection, designing, implementing and evaluation.

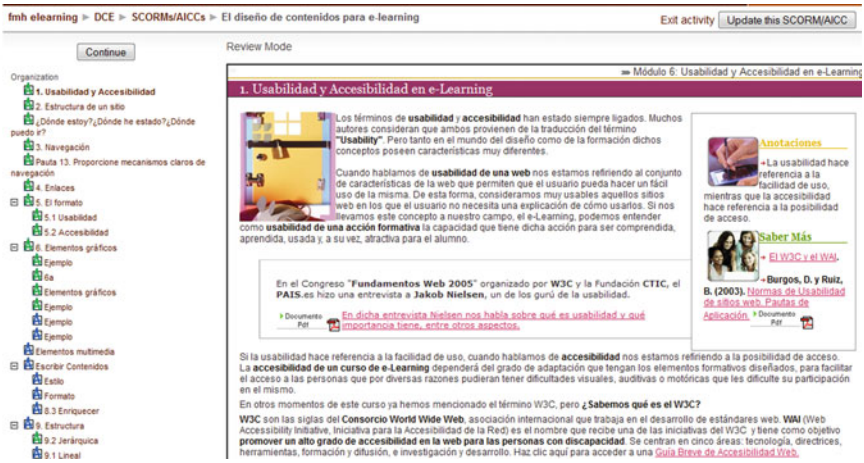

Fig. 11.6 An example of a course activity in LMS Moodle based on SCORM format

11.5 Inclusive Trends in HE: The MOOCs Case

The emerging concept of Massive Open Online Courses (MOOCs) recently introduced by Downes and Siemens (McAuley et al. 2010), i.e., free online courses designed to be an all-inclusive learning experience, is based on a wide blend of traditional tools, such as video lessons, evaluation tests and final exams combined with Web 2.0 tools (e.g., community of learning, wiki, blog, social media), and they are already offered by the top USA institutions, like Harvard, MIT or Stanford. At the same time, MOOCs methodology naturally suggests opportunities in many areas, namely in research areas of learner motivation, engagement, social presence and instructor presence (Koutropoulos et al. 2012).

Based upon *connectivism* and considering particular characteristics, such as diversity, autonomy, openness, self-organization, interactivity/connectivity for sharing knowledge, MOOCs can represent a unique opportunity to discover more about how, where, when, what and with whom people can learn in large open networks. This connectivism embraces complexity theory when referring to the organization of the course, which enables participants to connect outside of the learning environment and influence the course simultaneously. Mackness et al. (2010) found that when the *theory of connectivism* is used in the practice of a MOOC, its network principles of diversity, autonomy, openness, and emergent knowledge are included, giving it the characteristics of a complex system. Dynamic conditions of self-organization, such as openness of information flow, freedom, interconnectedness, and collective emergence can all be found in MOOCs. In other words, the latter can be seen as a complex system that is naturally self-organized, connected and open. Laroche et al. (2007) added that:

> (…) fluid environments have fuzzy and penetrable boundaries; they blur distinctions between schools, universities, nature and society, while juxtaposing formal and informal educational settings. Fluid environments are conducive to emerging non-orthodox forms of educational research (p. 6).

From this perspective, fluidity can be positioned within the connectivism theory from which MOOCs emerged, embracing the process as a natural product of openness and self-organization. Actually, a MOOC is based on principles of universal access, it is widely available to most everyone with Internet access and (in most cases) free to connect (generally has capability to include 500 participants). In a pedagogical perspective, it embraces an open, social structure, constructivist, and a connectivist way of knowledge production. To this end, anyone is free to connect, create, interact, analyze, and reflect according to his/her own learning needs.

Although the new versions of MOOCs differ from how Siemens and Downes conceptualized them, one characteristic that both early and contemporary MOOCs have in common is that they leverage a multitude of emerging pedagogies and tools, including b-learning, open educational resources, and crowd sourced interaction (Johnson et al. 2013).

In fact, MOOCs have been carried out using a variety of (mobile) tools and so may or may not use an established LMS. There are, however, specific areas in which MOOCs need to advance in order to better facilitate the capturing of relevant data to their structure (e.g., determining who is an active participant, and when/why participant drop out completely) (Koutropoulos et al. 2012) or finding new mechanisms for understanding the quality of interaction *per user*.

11.6 Final Considerations

There are indicators that showed that users (teachers and students) are motivated to use the LMS Moodle and the OLE seems to be flexible and user-friendly (see Chaps. 7 –10). At the same time, a more concrete awareness of the profiles enables teachers to choose more accurate teaching strategies to meet the students' specific requirements, something that could be of particular interest for students with disabilities or learning difficulties, enhancing, therefore, the level of co-responsibility and educational value about accessibility issues for inclusive b-learning scenarios in HEIs.

In terms of recognizing, understanding and responding to the academic community's specific needs, an inclusive perspective for choosing/implementing adjustable instructional strategies to improve b-learning environments has explored in this chapter. In fact, recent literature has reported some evidence about students' feedback and the eXe training provided. More specifically, in the context of a postgraduate course in Library and Information Sciences, the results have showed that most participants found eXe easy to use, mainly due to the usability and simplicity of the software and the appropriateness of the training (Marques and Carvalho 2012). Accordingly, the exploration/integration of more inclusive frameworks and universal instructional design principles, specially tailored to the needs of the LMS Moodle users (Elias 2010), focused on techno-pedagogical strategies is further required.

From the literature, it was also possible to clarify that the combination of factors that characterize the MOOCs vision in the education and the use of new (mobile) technologies make them a possible solution in the search for innovative online educational environments. Actually, MOOCs have been growing in popularity with educational researchers, instructors, and learners in online environments; however, current MOOC models still largely personify traditional lecture formats (Johnson et al. 2013).

In general, to cope with inclusiveness, dynamic support is also required to complement the universal design approach. Learners experience a disability when there is a mismatch between the learners' needs (or preferences) and the education or learning experience delivered. Thus, the system should take into account the preferences of the learners and the device capabilities when interacting with it and map them to specific content features (e.g., those related to the display, control and selection of learning content, so that alternative contents can be provided).

For example, for the case of deaf students the adaptation of the LMS could include:

- Bilingual (written language and sign language) information presentation. Sign language videos may optionally be retrieved for each text block. This makes the imparting of the learning content easier and increases the motivation of the learners; it allows independent learning and gives the deaf learners the feeling that they are being taken seriously in their cultural and linguistic identity.
- Developing of the user interface (user interaction, functionality and screen design) according to the requirements of the deaf communities. The icons that symbolize the different templates could be designed by deaf researchers themselves, who know of deaf people's high need for visualization.
- Inclusion of different kinds of exercises and tests that allow for a high amount of possible interactions. Graphically oriented exercises, such as hotspot or drag and drop tests, could support the explorative learning process.
- For a group of learners, for whom the modality of their language, i.e., sign language, is oriented at the special dimension of visual presentation, a high amount of visualization is needed. This could be achieved by the simple integration of standard multimedia formats.
- Inclusion of an integrated communication module consisting of video conference and chat, which could enable the users to learn in peer groups.
- The use of templates for pages, exercises, and tests, which could make the creation of the learning content much easier and guarantee a homogeneous and clearly arranged design.

Despite available legislation and expected benefits from student-centered approaches in HE, leveraged by the European Higher Education Area (EHEA, www.ehea.info), from enrolment to assessment, students have to negotiate pre-established general procedures. As pointed out by the European University Information Systems Organization (EUNIS, www.eunis.org), these procedures are nowadays mediated mainly by technology and intended to fulfill a "standard" set of needs; yet, they are far from considering the students' individual needs and preferences. In fact, it is disturbing to note that the most basic requirements of people with disabilities are usually not attended in HE (Seale 2006), and very often it is due to the unavailability of information before-hand, the lack of pre-established procedures to attend particular needs and the multiple and diverse barriers that have to be overcome to provide the required infrastructure.

In considering the role that technology and e-learning can play in helping students access higher education and an effective learning experience, a large amount of the current research and practice literature focuses almost exclusively on accessibility legislation, guidelines and standards, and the rules contained within them. One of the major problems of such an approach is that it has drawn higher education practitioners into thinking that their objective is to comply with rules. However, this is not the case in real-life scenarios. The objective should be to address the needs of students. The danger of only focusing on rules is that it can constrain thinking and therefore practice. We need to expand our thinking beyond

that of how to comply with rules, towards how to meet the needs of students with disabilities, within the local contexts that students and teachers are working. This, in turn, could guide e-learning technological solutions, like LMS, towards adaptation to users' cultures, policies and needs in a holistic approach that ensures the accessibility solutions chosen are appropriate for the context in which the resource will be used and inclusive and accessible learning experiences could be fostered.

With the inclusive learning issues presented in this chapter Part III is completed; what follows lies within the viewpoint of the overall perspective, reflecting on the presented topics and probing into to the future trends.

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Part IV
Overall Landscape

Chapter 12
Coda and Critical Discussion: A Systemic Analysis of an Intelligent OLE

12.1 Introduction

Most educators focus on products (e.g., exams, portfolios, tests, assessments) rather than processes, i.e., the tangible cognitive/intellectual development during a learning activity. Nevertheless, the present book has placed emphasis mainly upon the characterization of the online instructional process, in order to scientifically analyze the opinions and actions (trends, profiles and modeling perspectives) of the users of the LMS Moodle in b-learning mode. At the same time, the book unfolds an intelligent model that represents a contribution for improving the quality of users' interaction with the LMS Moodle, and, in general, a cultivation of an instructional practice more suited to the needs of an academic community.

The overall landscape that Part IV introduces begins with this chapter that provides a synopsis of all research conducted, synthesizing and linking the main results/considerations presented in the previous chapters, and critically discusses a systemic and multi-dimensional analysis of an intelligent OLE from a contextual, inclusive and adaptive perspective. Based on macro, meso and micro levels of understanding, a structured overview around the concept of intelligent LMS (*i*LMS) is given in Fig. 12.1. The latter generally illustrates different areas in which OLEs are used to support learning processes and outlines emerging new educational lines/concepts. In fact, from an interactive ecological perspective, the individual users' actions to advance need to be understood within an interconnected context of systems, which, following Bronfenbrenner (1997), can combine micro, meso, exo and macro systems examination. In Fig. 12.1, the exo-level is included in micro- and meso-level of analysis, since the exo-systems influence the behavior in micro-systems, yet the individual does not have direct contact with or influence over them.

The online communication channels considered in Fig. 12.1 should not be seen as static, yet with fluidity, directed to provide flow opportunities of communication in human–computer interaction in an OLE. In general, these channels are regulated by individuals/groups/communities that interpret, modify and use them for specific purposes, beginning with some type of knowledge (macro, meso, micro) and then, intelligently, moving through the following stages:

S. B. Dias et al., *Towards an Intelligent Learning Management System Under Blended Learning*, Intelligent Systems Reference Library 59, DOI: 10.1007/978-3-319-02078-5_12,

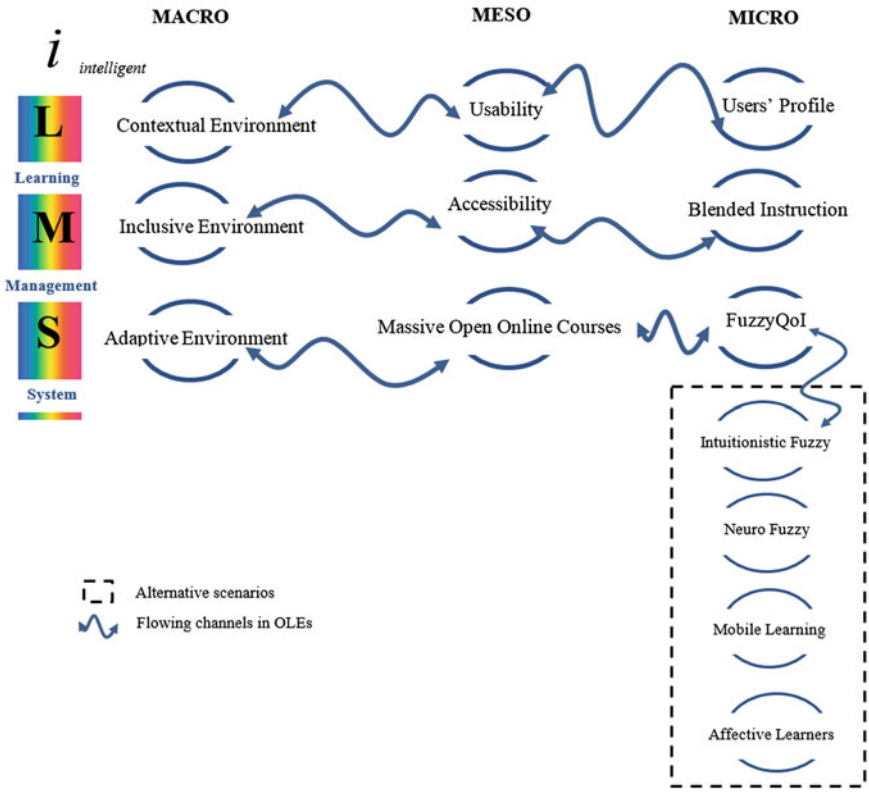

Fig. 12.1 *i*LMS: A systemic analysis from an intelligent OLE perspective

- exploration;
- (co)creation;
- dissemination;
- personalization;
- implementation;
- evaluation; and
- innovation.

However, according to Poff (1997): "Society's ability to maintain and restore the integrity of river ecosystems requires that conservation and management actions be firmly grounded in scientific understanding" (p. 769).

At the macro level, the following key areas can be distinguished (see Fig. 12.1):

- contextual environment,
- inclusive environment, and
- adaptive environment.

Globally, from a common use of LMSs, these three aforementioned macro perspectives together can support *intelligent* (*i*) areas for innovation in education,

represented by the concept of *i*LMS. This is explored in the succeeding sections that deep in each key area, following the macro-meso-micro trajectory.

12.2 Contextual Environment

12.2.1 Usability

The results of Chap. 7 have shown that although most teachers experienced different online activities in LMS Moodle (e.g., resources, forums, chats, glossaries, quiz, discussions, wiki, referendum), only a moderate number of them employed activities that predominantly stimulate collaborative, interactive and synchronous work (e.g., wiki, quiz, chat, SCORM). Considering these results, the multifaceted e-moderator's role should be comprehended as a creative one, expressed through appropriate e-activities in different stages of learning, i.e., based on the individual time/pace of learning and the needs/motivation of each student, promoting, simultaneously, a progressive increase in the intensity of interaction (Salmon 2000). Fortunately, some HEIs already use in the LMS Moodle other open source solutions (e.g., LAMS), which have been proven to be quite functional and user-friendly in multitasking support, in terms of designing and managing/structuring online collaborative learning activities (Dalziel 2006; Cram et al. 2010).

In this line, the results from the case study of Chap. 7 served to better understand the perspective of teachers and students as LMS Moodle users at a HEI, revealing, the following outcomes:

- the LMS Moodle was considered:
  - a user-friendly environment, that predominantly stimulates the use of asynchronous tools;
  - a valuable environment that can support online socialization and information sharing; and
  - a privileged space that promotes learner's autonomy;
- the development of personal skills (teachers' perspective) and the construction of social networks (students' perspective) were considered as main potentialities of the LMS Moodle;
- a significant relationship between innovation (in the context of using communication tools) and ease of use of LMS Moodle was established;
- the satisfaction level of the students in LMS Moodle use was associated with student's autonomy as a learner;
- the efficiency of the LMS Moodle was associated with the teacher's role, regarding effective information sharing among all stakeholders.

The above results extend the results from the previous work of Zhang and Wang (2005), who, through a comparison across 17 LMSs at the level of their

communication (asynchronous, synchronous) and collaboration (file exchange, workgroup, whiteboard) features, revealed that only the discussion forum, internal email, chat, file sharing and collaborative work in small groups could be considered the most essential tools in the development of an effective LMS.

12.2.2 Users' Profile

In general, in Chap. 8, ICTs were identified as potential tools of synchronous and/or asynchronous helpfulness, able to integrate multiple resources (considering models of interoperability, reusability and usability) in interactive learning environments, with respect to the objectives and individual/collective needs. The profile of teachers identified in the case study of Chap. 8 revealed, in an inductive way, different dimensions of b-learning knowledge, grouped into four domains, i.e.:

- activities;
- interaction;
- collaboration; and
- assessment.

In addition, the results of Chap. 8 seem to confirm that there is a strong relationship between the use of distinct asynchronous tools (e.g., resources, links, and glossaries), the repository of information and content, and the teacher-student-content interaction. On the other hand, there was a strong correlation between the use of different communication tools (e.g., blog, wiki, chat) and the level of education (i.e., the use of the LMS Moodle is more advantageous in the courses of Master's and Doctoral degrees than in the undergraduate ones). Furthermore, a positive association between the use of works submission and learning activities (e.g., inquiry, referendum, quiz) was also observed. In addition, the results confirmed a positive relationship between the sharing of information and the online tasks. In general, the results of Chap. 8 are in line with other studies, which argue that teachers use the management system mostly as a repository of content and as an administrative tool, and less as a tool of communication, interaction and learning (Badge et al. 2005; Morgan 2003; Mott 2010). The results of the Chap. 8 also stress the need to rethink new models from institutional strategies, essentially at the levels of the organization, pedagogy and technology. In this line, these results support recommendations from other authors, such as Bates and Sangrà (2011), who suggest the TOPs model. Also, the TPACK model (Mishra and Koehler 2006), using an empirical-conceptual approach, highlights the need for the development of teacher's skills with regard to the integration with ICT, when using a LMS. Focusing on the interaction and the complexities of different types of knowledge (e.g., PCK, TCK, and TPK), this approach can be used as an instrument and potential facilitator for the understanding of knowledge/skills integration of effectiveness of b-learning methodologies. In fact, Chap. 8 emerges from the need

to promote a more harmonious academic community, innovative and versatile, in order to better respond to the different sceneries of b-learning. In this sense, in an attempt to address these needs, some evidence shows that technology innovation underlies the re-appreciation/implementation of techno-pedagogical models as key elements to the institutions that desire success and effectiveness in the 21st century (Peraya and Viens 2005; Sarirete et al. 2008).

Chapter 9, by using qualitative and quantitative methodologies, tried to prove the functionality of an OLE, considering, among other aspects, the interactivity of the learning environment, the beliefs of teachers in relation to ICTs, and the training of students, specifically concerning ICTs use. More precisely, the results from the case study of Chap. 9 suggest that there is a positive relation between: the use of different (synchronous and asynchronous) communication tools (webmail, chat), the benefits of interaction (teacher-student interaction, sharing of information), a sustainable education (self-regulated learning), and the ease of use (accessibility, efficiency in learning). Additionally, Chap. 9 recognizes the importance of ICT knowledge from teachers in the use of the LMS Moodle, taking into account the teachers' beliefs and curriculum differentiation. A positive association between: the lack of time, the lack of systems and applications interoperability (linkability with other systems), the lack of technological knowledge (ICT training), and the usability of LMS Moodle was also identified. A new perspective of LMSs in b-learning context was also presented in Chap. 9 with regard to the analysis of students' profile to identify optimization processes, serving as feedback for the LMS and, consequently, to contribute to effectiveness (satisfaction/intrinsic motivation) of b-learning modality. Accordingly, the feedback in online systems is often associated with the kind of interaction that is established; in other words (Simonson 2005): "Feedback permits those involved in communication in a distance education system to evaluate the process" (p. 263). In this perspective, an effective interaction requires a proactive audience. In line with the results from Chap. 9, some evidence show that the implementation and the development of an online course essentially depend on effective strategies of motivation and feedback used, focused on the development of learning situations and active participation (Lynch and Dembo 2004; Yengin et al. 2010).

12.3 Inclusive Environment

12.3.1 Accessibility

From a practical point of view, an inclusive b-learning environment can be seen as an opportunity to enhance an HEI position, expand access to HEI educational offerings and substantially reduce functional costs. In general, authoring tools seem to incorporate two different categories, i.e., multimedia design tools (Kraithman and Bennett 2004) and tools that mainly stimulate disability (Saito et al. 2005).

Towards an inclusive b-learning environment, among others, interactive tools, interoperability/linkability issues, educational standards (e.g., SCORM, Tin Can API), multi-modal resources, instructional differentiation, assessment/feedback resources must be incorporated in the LMS Moodle to support different types of users with different needs. The *right* combination of tools has the potential to help teacher to recognize that accessibility is just an important pedagogical issue and, at same time, a technical one. As Seale and Cooper conclude (2010):

> (…) generic pedagogical tools on their own are likely to have a limited or abstract influence on the development of accessible e-learning; but that this influence could be potentially increased by 'blending' the use of specific accessibility tools with the use of more general pedagogical tools (p. 1114).

In fact, several research efforts try to develop inclusive LMS that go further than only complying with the Web Content Accessibility Guidelines (WCAG, www.w3.org/WAI/intro/wcag.php), offering pedagogical tools with some kind of adaptation (Seale and Cooper 2010).

Actually, some implementations demonstrated in Chap. 11 seem to link the gap between inclusive/adaptive learning systems/resources and LMS Moodle developments, covering some personalization and accessibility issues in actual practice of the HEI within the sociocultural context (e.g., embedding EU4ALL framework, SCORM format, eXelearning object). In fact, the EU4ALL approach implemented in the examined case study of FHK, seems to provide the technical means of efficiently bringing to the learners resources/activities that support their needs and preferences, including their accessibility needs.

Furthermore, accessibility with regard to design tools generally embraces both accessibility guidelines and accessibility standards. The most well-known *accessibility guidelines* are the WCAG developed by the web accessibility initiative (WAI) of the World Wide Web Consortium (W3C 2008). On the other hand, *accessibility standards* that are specific to online learning and education have also been developed, e.g., the IMS Global Learning Consortium Standards (IMS Global Learning Consortium 2004) and The Learning Federation Accessibility Specification for Content Development (The Learning Federation 2007). However, there is a need to look more closely at the context in which tools are introduced, emphasizing the institutional context of accessibility (Seale 2006). For instance, Cooper (2006) has described how responsibilities for accessibility can be shared between educators and developers in the Open University context, underlying the following five principles of software accessibility:

- allow for user customization;
- provide equivalent visual and auditory content and interface elements;
- provide compatibility with assistive technologies;
- allow users to all functionality from the keyboard alone; and
- provide context and orientation information.

Moreover, an eclectic range of projects have dedicated on accessibility and disability issues, for instance:

- the *Through Assistive Technology to Employment* (TATE) project: in producing health and safety training materials to support people with learning difficulties in employment (Beyer 2007);
- the *Multimodal Collaboration Environment for Inclusion of Visually Impaired Children* (MICOLE) project: in developing systems that support collaboration, data exploration, communication and creativity of visually impaired (Jarvi 2007);
- The *Communication and Rehabilitation Engineering at Sheffield* (CORES) project: in incorporating user's modeling to support the required degree of flexibility and intelligence to dynamically adapt the user interface to the users' needs, regarding speech characteristics (Cudd 1994).

Generally speaking, good design for people with disabilities is good design for all. Accessibility is determined by the flexibility of the e-learning system and the availability of adequate (alternative) content and activities. The needs/preferences of a user can emerge from the context/environment that s/he is in, the tools available (e.g., braille devices, voice recognition systems, or alternative keyboards), his/her background and the existence of a disability in the traditional sense (Cooper 2006).

In fact, in Chap. 11, the users' profiles were schematically presented as an additional source of information, in order to support optimization processes, increasing the level of co-responsibility and the educational value about aspects related to accessibility issues of the b-learning scenarios to the receivers (teachers and students). When teachers are specifically encouraged to consider accessibility, they are able to incorporate accessibility issues into their personal pedagogical models of practice (DeFreitas et al. 2008).

It is therefore essential to continue to analyze how the teachers customize and innovate their curricular content, facilitating the work of specialists in the design of teaching materials and compromising the customization consistent with the pedagogical models (Tattersall et al. 2005).

Intelligent and interactive educational management systems appear to mobilize agents of innovation and provide flexibility and accessibility in educational contexts e.g., through multidisciplinary collaborative networks. In addition, the development of learning environments can be seen as an opportunity to implement/develop innovative tools, which enable to enhance a new quality of learning (e.g., self-guided/regulated, dynamic, interactive, collaborative), through the optimization of processes that comprise the profiles of users and their practices.

The real changes with regard to teaching and learning, as well as the renovated curricula/courses supported by ICT, appear to influence the culture of the universities. Multicultural and inclusive society acclaims a model showing the coexistence of cultures and beliefs, in a varied (multisensory) and polite learning environment - so in essence the character and the human virtues, essentially aimed at strengthening a harmonious interpersonal atmosphere, i.e., *sociocultural homeostasis* (Damásio 1994).

12.3.2 Blended Instruction

Nowadays, HEIs have a myriad of learning approaches, choices and opportunities. The concept of b-learning is embedded in the idea that learning is not just a one-time event, i.e., learning is a *continuous* and *dynamic process*. Combining different delivery modes has the potential to balance out and optimize the learning development, deployment costs and time. Actually, the literature offers different definitions of b-learning, commonly describing it as the mix of traditional methods of teaching, such as face-to-face teaching, and on-line teaching.

For instance, according to Bliuc et al. (2007), the b-learning concept refers to "learning activities that involve the systematic combination of co-present (F2F) interactions and technologically-mediated interactions between students, teachers and learning" (p. 242). In addition, Bonk and Graham (2006) refer to b-learning when two learning environments converge. Singh (2003) understands b-learning as a combination of multiple delivery media designed to complement each other and promote meaningful learning. Furthermore, Garrison and Kanuka (2004) refer to b-learning as a simple and complex environment that integrates classroom F2F learning experiences with on-line learning experiences. Moreover, Driscoll (2002) understands b-learning as:

- a mixture of modes of Web-based technology;
- a combination of various pedagogical approaches, e.g., constructivism, behaviorism, cognitivism, conectivism;
- a mixture of any form of instructional technology with F2F instructor-led training; and
- a combination of instructional technology, in order to create an effective mix of learning and working.

Moreover, Oliver and Trigwell (2005) propose some distinct terms to capture the true meaning of the b-learning concept, i.e., "blended pedagogics", "blended teaching" and "learning with blended pedagogies". In addition, they also refer to the *blendedness* of media or pedagogies, as the combination of media and tools employed in an e-learning environment, or the combination of a number of pedagogic approaches. In fact, the teacher needs to adjust his/her instruction in response to the students' needs. The purpose is to construct mutual accommodation and respect for the culture of others in order to reach academic success (Protheroe and Turner 2003). Cultural connection or disconnection in online learning environments can be considered as an interaction between multiple cultural dimensions, namely (Henderson 2007):

- external level (e.g., ethnical or national culture);
- internal level (e.g., learners' age, gender, personality, and life experience); and
- academic level (e.g., domain culture and instructional context).

From the results of the case study of Chap. 8, when focusing on the instruction context of the examined HEI (i.e., FHK), four different dimensions of educational knowledge were identified, i.e., *activities, interaction, collaboration* and *assessment*, suggesting that teachers have to (re)think, holistically and systemically, blended instruction, in order to promote a more harmonious and comprehensive, online community.

From a holistic perspective, the main benefit of b-learning is to provide a sense of community amongst learners (Garrison and Kanuka 2004). In addition, it is important to underline that F2F interaction still matters, transmitting a lot of facial expressing, body language, tonality of voice and eye interaction. Actually, as innate elements of our life, the brain needs/expects these channels of information. Visual information and emotions (e.g., smiles) are vital to communicate and, actually, they do not exist in OLEs. Designing courses in b-learning mode has to be seen as a flexible approach, combining some conveniences of fully online courses, yet without leaving out the F2F contact/communication/presence (Rovai and Jordan 2004). In fact, equilibrium between F2F interaction and online access is crucial (Osguthorpe and Graham 2003).

Especially, with regard to students' learning experience, student–student interaction and student-instruction interaction, b-learning approach seems to arise as the predominant instructional model in the future. However, from the different types of interactions, the instructor-student interaction (which occurs when the instructor and students work/communicate with each other) is the key element for the successful instruction (Thurmond and Wambach 2004; Appana 2008). Interacting with the whole group or with specific individuals (i.e., online instructional differentiation) could be seen as a solution to help learners to better understand course requirements.

12.4 Adaptive Environment

12.4.1 MOOCs & Key Trends

MOOCs approach in OLEs and their potentialities in education context were generally presented in Chap. 11; however, from a critical point of view, it is important to discuss some other key trends.

In general, some LMSs may evolve from course-delivery systems towards adaptive learning environments that personalize the experience based on the learner's performance. Recently, Johnson et al. (2013) have identified six key trends that seem to cause some angst in traditional HEI cycles, as tabulated in Table 12.1. The significant challenges described in this report are similar to those in the past, such as: lack of faculty development or training in digital media literacy or resistance to change. Furthermore, the demand for the use of learning analytics, the continued growth of new educational models, and the continuing resistance of faculty are challenges surfacing in HEIs (Johnson et al. 2013).

Table 12.1 Key trends for higher education. (Johnson et al. 2013)

Key trends	
Openness is becoming a value	A common vision emerges that assumes the open concept as free, copyable, remixable, and without any barriers to access or interaction
Massively Online Open Courses	MOOCs are being widely explored as alternatives and supplements to traditional universities
Workforce demands acquired from informal learning experiences	The emphasis is on critical thinking and communication skills
Data Analytics	Learning analytics experiments are examining ways to use data for enrichment. These are also used to personalize learning and identify students with special needs
The changing Role of Educators	Mentoring emerges, due to the vast resources that are accessible to students via the Internet
Educational Models	Education paradigms are shifting to incorporate online, hybrids/blends, and collaborative learning environments

In fact, MOOCs generate massive quantities of data about the learner's behavior, which can be used to understand cognitive growth and how to improve instruction. In other words, MOOCs represent a convergence of technology and culture that is creating new ideas around OLEs.

Generally, online learning technologies that are commonly used in MOOCs incorporate (EDUCAUSE 2012):

- high-quality indexed video;
- data capture and analytics; and
- delivery platforms that combine the qualities of social networking sites, like Facebook, with the content delivery, discussion, and grading functions of the traditional LMS.

Furthermore, in the framework of highlighting the technologies that have emerged with huge potential, it is worth referring to the six promising technological areas featured in the work of Johnson et al. (2013) (see Table 12.2).

From Table 12.2, it possible to observe some projections of the emerging tools based on a time line that directly corresponds to six different technologies; more specifically (Johnson et al. 2013):

Table 12.2 Emerging technologies in the education area. (Johnson et al. 2013)

Time frames	Emerging technologies
1 year or less	Massively Online Open Courses & Tablet Computing
2 to 3 years	Gaming and Gamification & Learning Analytics
4 to 5 years	3-D Printing & Wearable Technologies

- *MOOCs*: they offer the possibility to continued, advanced learning at zero cost, allowing learners (i.e., LLL) to acquire novel skills and improve their knowledge and employability, in general.
- *Tablet Computing:* it is essentially seen as a portable and always-connected family of devices that can be used in almost any setting. Many universities have designed software for tablets following best practices guidelines for both educators and learners.
- *Games & Gamification:* the games in higher education aim to engage students with digitally enhanced scenarios; the gamification aims to understand how elements of game design are informing curricula.
- *Learning Analytics:* is the field associated with deciphering patterns/trends from educational big data to gain insights about student's behavior/learning. From a refined perspective, student-specific data can be used to personalize online course platforms.
- *3-D Printing:* it provides a more accessible, less expensive, desktop alternative to industrial forms of rapid prototyping, already implemented in research and lab settings.
- *Wearable Technology:* it refers to the incorporation of devices and related electronics into clothing and accessories. For instance, in the Google's "Project Glass", augmented-reality-enabled glasses display relevant information for users as they go about their daily routines.

In fact, "As technologies are continuously designed to be smaller and more mobile, wearable devices are a natural progression in the evolution of technology" (Johnson et al. 2013, p. 33).

12.4.2 FuzzyQoI

From the results of Chap. 10, it can be concluded that the presented FuzzyQoI scheme exhibits increased adaptivity to the true nature of QoI, following the findings of the studies that were previously developed (Chaps. 7–9). In fact, the FuzzyQoI scheme shows noticeable flexibility and robustness against highly dispersed input data (both from professors and students). This justifies the adoption of the fuzzy logic in its structure, since, equipped with the latter, it successfully deals with the uncertainty and subjectivity associated with human performance assessment. In this way, possible bias generated by the expert's mapping of the qualitative data to the universe of discourse is circumvented by the inherent structure of the FuzzyQoI scheme. As a result, the proposed approach "absorbs" the subjectivity often met in the interpretation of the LMS Moodle variables and it can be successfully extended to different coding of b-learning, i.e., by the employment of other variables apart from "Action" (sole and combined with "Module").

This was also supported by the findings of Abdelraheem (2012), who investigated the relationship of students' gender, grade point average, individualized

learning experiences and their experiences using computer as factors in perceiving the QoI with LMS Moodle. In his study, Abdelraheem (2012) found no statistically significant differences in the means of the four variables; he explained his findings considering the widespread penetration of computers into educational fields and into the society at large in the recent years, which enabled students to develop more positive perceptions of ICT-based applications, independently of their basic individual, such as gender, computer experience, and individualized learning experience (Abdelraheem 2012).

Finally, the efficiency of the proposed FuzzyQoI scheme to capture the trends and internal dynamics of QoI justifies the adoption of fuzzy logic in the field of education, while, simultaneously, motivates and paves the way for an alternative approach to LMS-based b-learning modeling. In this context, managerial implications could be tracked; in fact, the results presented in Chap. 10 encourage LMS managers/designers to include the measure of QoI (from all users' categories, i.e., students and professors) and via the latter reflect upon issues like system-quality, system-use and user-satisfaction into their present evaluation techniques of LMS-based b-learning systems efficiency. This evaluation would provide a fast and early feedback to the academic institutions to enhance their understanding of the level of online learning systems efficiency and take corrective actions, if necessary, for improvement at a more administrative level. Due to the worldwide adoption of LMS Moodle in the educational practice, the FuzzyQoI scheme could be applicable across a broad spectrum of b-learning, and in general e-learning, systems, providing a common framework for comparative critical analysis. To this end, the efficient scaling and reliability on the basis of analyzing data from a sample of the FuzzyQoI scheme, allow the framework, when necessary, to be adapted or supplemented to fit the specific practical needs of a particular online learning environment.

12.5 Alternative Scenarios

12.5.1 Intuitionistic Fuzzy and Neuro-Fuzzy Modeling

The fuzzy systems embedded within the FuzzyQoI model could further be enhanced with the adoption of intuitionistic fuzzy set theory (Atanassov 1999, 2012; Hadjileontiadou et al. 2013), so to better accommodate the experts' hesitancy during the transfer of his/her expert knowledge to the structure of the membership functions and fuzzy rules.

In addition, the concept of neuro-fuzzy modeling (Jang and Chuen-Tsai 1995; Hadjileontiadou and Hadjileontiadis 2003; Abraham 2005) could also be examined, so the model membership functions and fuzzy rules could automatically be constructed through an optimization process, considering some input/output training data.

Moreover, a comparative performance analysis of the resulted intuitionistic fuzzy model, the neuro-fuzzy model and the FuzzyQoI model would allow for hybrid modeling approaches, combining the benefits of each fuzzy modeling approach.

12.5.2 Mobile (m-)Learning

In order to integrate the b-learning context into the regular curriculum at HEIs, mobile access to LMS also has to be facilitated. According to Minović et al. (2008):

> Mobile devices have potential to be integrated into the classroom, because they contain unique characteristics such as: portability, social interactivity, context sensibility, connectivity and individuality (p. 561).

The expansion of mobile devices with new browsing capabilities and touch interfaces provide new ways to learn, such as mobile (m-)learning, within the context of b-learning. Using hi-tech environment (i.e., interactive lectures that integrate PCs, laptops, PDA, mobile phones), the teacher can move freely in the room, use his body language to communicate, and also interact with learners naturally and easily, as in a traditional F2F classroom (Shen et al. 2009). In general, online learning has advanced from computer aided instruction, through intelligent tutoring system, to smart classrooms and to m-learning (i.e., OLEs with mobile devices).

The innovation in the mobile interfaces, which could contribute to the m-learning in the near future, has recently peeked up with the introduction of Google Glass (http://www.google.com/glass/start/). While smartphones and tablets have already radically revolutionized education, Google Glass may soon become the new game-changing technology in m-learning. Set to be available to the public in late 2013, Google Glass promises to add a new dimension to the constantly growing list of things that can already be done with handheld mobile devices. Equipped with voice recognition, object recognition, a heads up display (HUD), and bone-conduction audio (see Fig. 12.2), Google Glass could enhance m-learning with the following features:

- *Augmented reality*: Augmented reality is a live view of the real world enhanced by computer-generated contextual layering of information. Google Glass is in essence an augmented reality device, as it features a HUD consisting of a projector and a prism, which purportedly generates a display equivalent to a 25-inch high definition screen from eight feet away. This display overlays data and graphics onto user's field of view and combines this information with his/her real-world environment. Accordingly, augmentations can be used to create learning solutions that are not only visually engaging, highly interactive, and easily accessible, but also contextually relevant. Indeed, one advantage of

Fig. 12.2 An example of the functionality of the Google Glasses (adapted from http://royaltimes.net/wp-content/uploads/2013/02/google-glasses.jpg), as a forthcoming wearable means that adds to the m-learning within the b-learning context

Google Glass is that it can facilitate just-in-time learning (i.e., learning that occurs at a time and place when it is actually needed). With Google Glass, learners have the ability to intuitively access relevant "nuggets" of information as needed to solve problems or perform certain tasks (e.g., real-time tips and tricks).

- *Hands-free capabilities*: While Google Glass has many of the same features of most mobile devices, it also has the added bonus of being a wearable device in the form of glasses. This not only permits individuals the use of both hands, but also makes the device less disruptive, as there is no need to pull out and hold onto a device while performing an activity. Additionally, the hands-free functionality makes it easier for learners to follow step-by-step instructions either from pre-recorded videos or real-time instructions of a trainer.
- *Point-of-view (POV) training*: The ability to see from an individual's POV opens up new possibilities for training, and performance support and assessment. Trainers could give step-by-step instructions, provide feedback, and

evaluate the learner during an activity based on the learner's POV. Conversely, learners could visualize instructions from the trainer's POV, as well as record and review their own performance. This feature would be particularly useful in training scenarios where it would be hard to visualize a certain activity (e.g., training surgeons to perform a specific surgical procedure).

- *Real-time searching*: Being a Google product, the glasses will of course have the ability to conduct real-time searches for information. Not only will learners be able to conduct voice searches, they will also be able to conduct searches based on the objects and images around them thanks to the object recognition feature of Google Glass. This functionality will truly support just-in-time learning by enabling learners to instantly access specific sources of information at the moment they need them. It is clearly imaginative to be able to explore and learn about almost anything at any point of time without any previous knowledge. This feature would be best applicable in discovery- or inquiry-based learning situations, where learners are encouraged to research a certain topic.
- *Recording of training sessions*: Learners will be able to capture their relevant learning experiences through video, audio, and images for future reference. Conversely, trainers will be able to evaluate the learner based on their POV recordings. Additionally, conversations can be transcribed as notes, and even translated into real-time subtitles, which would eliminate language barriers and allow for globalized training. However, it goes without saying that there may be privacy concerns associated with recording, and therefore, ways around this issue will need to be considered (e.g., use of Google Glass in closed environments, such as training sessions, workshops, etc.). Indeed, a recent review of the Google Glass prototype suggests adding a red light on the front of the glasses as an easy fix to letting others know that you are recording.

Turning to the blended perspective, a recent initiative designed to open up the LMS Moodle to the mobile scenarios have been developed, namely Moodbile Project (http://moodbile.org.), i.e., m-learning for Moodle.

On the one hand, m-learning improves collaborative learning and increases learning flexibility, but, on the other hand, it reveals interoperability problems with LMS. From this perspective, the Moodbile project has proposed interoperability solutions to integrate m-learning applications with the LMS, incorporating m-learning applications into the learning process of educational institutions (Casany et al. 2012).

12.5.3 Affective Learning

In OLEs, learners do not see teachers' expression of encouraging/criticizing, tending to decrease students' learning interest, in general. From this perspective, within LMS space, emotions should be seen as an important promising approach to encourage and develop positive emotions (motivation and interest) of learners.

Based on *emotional thought* concept (i.e., the large overlap between cognition and emotion) Immordino-Yang and Damasio (2007) note that:

> The more educators come to understand the nature of the relationship between emotion and cognition, the better they may be able to leverage this relationship in the design of learning environments (p. 9).

Actually, the capability to manage feelings and relationships is considered a kind of "emotional intelligence" that enables people to be successful. More specifically, emotional predictors of online success (e.g., emotional self-regulation, self-generated motivation, self-efficacy, internal locus of control) have been closely related with emotional intelligence (Holcomb et al. 2004; Kemp 2002; Irizarry 2002; Parker 2003; Wang and Newlin 2000).

According to Tucker et al. (2000), emotional intelligence can be included into the curriculum; Goldsworthy (2000) has integrated emotional intelligence into online instructional approaches by designing online educational materials for personal emotional skills that sustain motivation, self-confidence, and team work when people feel overwhelmed. From this perspective, biological sensors, such as electrocardiography (ECG), electroencephalography brainwaves (EEG), and eye tracking have been used for measurement of emotion of learner, providing selective quantitative or semi-quantitative analytical information using a biological recognition element (Thevenot 1999). More recently, Shen et al. (2009) have also integrated the heart rate (HR), skin conductance (SC), blood volume pressure, and EEG measurements to detect emotions of learner. Interestingly, Kittanakere et al. (2011) have introduced the design of an emotion sensitive e-learning system, giving specially emphasis to the learning process. This system categorizes a learner's emotional state as *Happy, Neutral,* and *Sad*, generally motivating to think about incorporating emotional aspects of teaching in online learning systems to make it more intelligent. In other words, these emotional plugins (as a set of objects which the system suggests to be plugged-into the technical module depending on the emotional state of the learner) can be seen as helpers in modulating the mood of the learner, enhancing the effectiveness of the learning process (Kittanakere et al. 2011).

Emotion recognition is one of the key steps towards affective computing. In this context, several efforts have been discussed to recognize emotions using facial expressions, speech and physiological signals (e.g., Picard et al. 2001). This field has been boosted recently due to the technological innovation seen in data acquisition devices that could be used in the affective computing. For example, a Bluetooth-based EEG device from Emotiv (www.emotiv.com) is a revolutionary personal interface for human computer interaction (see Fig. 12.3), which uses sensors to tune into electrical signals produced by the brain to detect user thoughts, feelings, and expressions. Based on the acquired information from the EEG data, a useful metric for measuring student's emotional state during learning. As an example, frustration could be measured and, in turn, various thresholds can then be established to trigger interventions from the OLE that will support student's confidence, provide remediation, or contact a live facilitator to assist the student.

Fig. 12.3 The Emotiv device (*up*) and its recording sites on the brain (*down*) (adapted from www.emotiv.com.)

In addition, Emotiv could also assist students with mobility problems to use their brain activity for interaction with the computer, since it provides brain-mouse and brain-keyboard control potentialities.

Another potentiality in affective learning could be traced through the use of Microsoft Kinect 2 device (www.microsoft.com), set to be available to the public in November 2013. The new video capabilities of the Kinect 2 allow for incredible accuracy when it comes to recognizing the user and his actions. The new hardware allows the console to understand not only the user' position, but his/her balance, the way s/he shifts his/her weight and even to monitor his/her heartbeat during interaction. Using a combination of the color image feed and its Active IR sensor, Kinect 2 can "see" the pulse in the user's face (see Fig. 12.4a). Moreover, Kinect 2 captures also user's mood. By detecting nearly every detail of his/her face, the controller knows when s/he is smiling and when s/he is bored (see Fig. 12.4b). Moreover, Kinect 2 could perform such functionality for more than one user simultaneously (see Fig. 12.4b), allowing for group interaction during the learning process. Consequently, by using the user's affective information (as a combination of heart rate, gestures/postures and expressions) the opportunity for the OLE to act

Fig. 12.4 The functionality of Kinect 2 when capturing user's (**a**) heart rate and (**b**) mood (adapted from http://mashable.com/2013/05/22/xbox-one-kinect-heartbeat/). Note that in (**b**), the identified mood correspond to three users, interacting, simultaneously with Kinect 2

analogously is obvious, elevating the level of personalization to the user's affective status and performing the appropriate actions to foster his/her receptivity of learning.

From an educational perspective, as illustrated in Fig. 12.5, the main interest is to focus on the emotional aspects of the online systems using biological signals and/or gestural and facial expressions, in order to design *i*LMSs and tools/activities that avoid inappropriate affective feelings (such as anger, boredom, and anxiety). In addition, more internal issues of learners' system could be explored, when taking into account information from the affective domain. As examples, in a recent study, Hadjileontiadou et al. (2013), propose a modeling scheme of learner's complex system by reflecting Boulding's typology at the affective computing space, whereas Hernández et al. (2013) introduce an affective behavior model that considers the

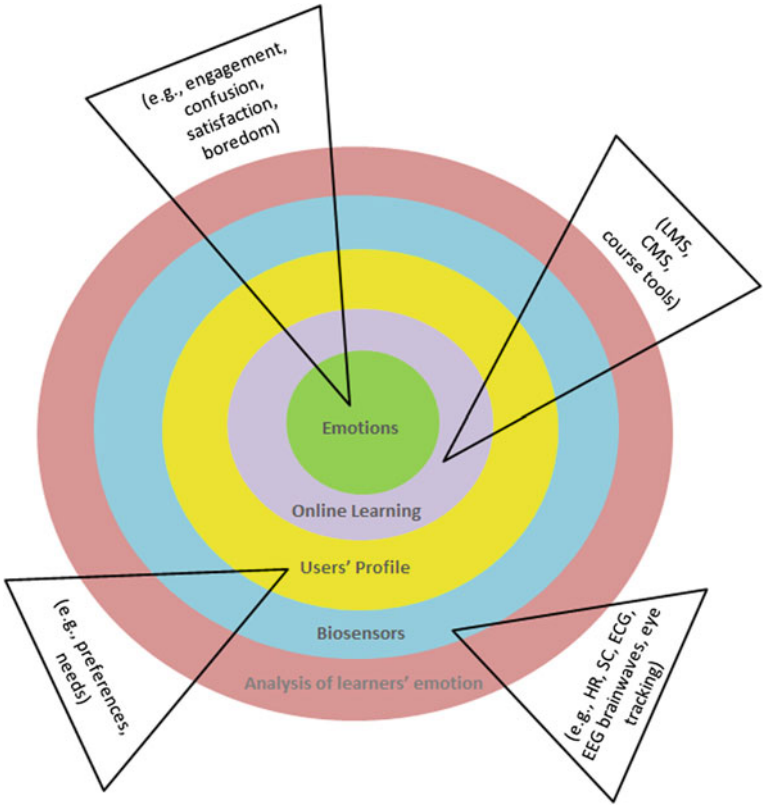

Fig. 12.5 From emotions to analysis of learners' emotions in OLEs and characteristic examples

affect and the knowledge state to provide students with an adaptive and intelligent instruction.

As a bottom line, an intelligent OLE should be able to adapt to the knowledge, emotions, learning abilities and needs/preferences of each user. In short, designing OLEs that focuses on user's emotions using affective state information captured from intelligent devices seems to be very promising approach for future refined investigations in the field of 21st century learning.

12.6 Cope Stone

From a common perspective, learners should be behaviorally, intellectually, and emotionally involved in online learning tasks. In general, the interaction between the LMS and other mobile applications/tools seems to require more interoperability developments. Generally, it is our hope that the ideas discussed in the present

chapter will provide an intelligent framework, based on *i*LMS concept, for possible reforms and alterations to the LMS-based b-learning modeling, and, hence, to effective process of online instruction.

The chapter that follows provides a closure of the book, presenting the main contributions, recommendations, concluding remarks and probes to the future.

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Chapter 13
Concluding Remarks and Probing Further

13.1 Introduction

Reaching the final destination of the journey started in Chap. 1, this closing chapter pragmatically exposes a summary reflection of the main considerations and contributions and, at same time, provides a guide for future research decisions/investigations. After all, the key purpose of this book was to systemically understand—at the macro, meso and micro levels—the issues related to the trends, profiles and modeling perspectives towards an intelligent LMS under b-learning concept.

At this last stop, the emancipation of *i*LMS is established as a potential contribution to the twenty-first century learning, creating an ample space for reflection, extension and (re)thinking upon the intelligence of the OLEs as current and future (co)constructs within the educational context.

The knowledge awareness gained tracing the chapters of this book is re-experienced through the epitomized recapitulation and critical thinking that follows.

13.2 Concluding Remarks

The implementation/development of an effective online learning community in the context of higher education (and training) requires contributions, exchanges and sharing experiences to construct, in a medium-long term, an OLE that can intelligently respond to the specific needs of the students and teachers, in particular, and community, in general. Unequivocally, ICTs in an isolated form do not improve teaching or learning; yet, with these, it is possible to work, teach and learn in a more adapted and multimodal way, representing generous advantages for the whole academic community.

Following the core issues examined across the chapters of this book, the subsequent main contributions could be acknowledged:

S. B. Dias et al., *Towards an Intelligent Learning Management System Under Blended Learning*, Intelligent Systems Reference Library 59, DOI: 10.1007/978-3-319-02078-5_13,

- *Adaptable b-learning solutions*: it seems prudent to say that after the implementation of the LMS Moodle at a HEI (e.g., FHK), there is still the need to continue to pursue b-learning solutions, especially, more adapted to the requirements of students and teachers (of the twenty-first century), to improve the teaching–learning process and its intrinsic educational offer.
- *Development of techno-pedagogical strategies*: different structures of thought were identified, i.e., different LMS users' (teachers and students) profiles, suggesting the integration of techno-pedagogical strategies more adjusted, among other aspects, to their level of technological knowledge.
- *Sustainable institutional encouragements*: it is important to reinforce that b-learning methodologies will be only successfully used when the advantages of their use become more explicit, requiring, perhaps, more resilient and sustainable institutional incentives, motivations and circumstances.
- *Specialized LMS support and training*: it is essential to continue to develop a bright scientific work of dissemination and training and even more specialized support, in an effort to understand the cultural and social dynamics, and, therefore, create conditions to efficiently optimize, monitor, evaluate and innovate b-learning processes, environments, and contexts.
- *QoI index to monitor OLE interaction*: the QoI of teachers and students in LMS Moodle, approached here through the use of fuzzy logic that can handle the complexity and multi-variability of b-learning environments, can be used to develop a comprehensive and panoramic vision, which considers the human factor and the complex nature of b-learning, resulting in a quantitative explanation translated by the QoI index. The latter can represent a distinct path on approaching OLEs, since, on the one hand, it incorporates human subjectivity and, on the other hand, extends the experiences of monitoring of refined interaction processes based on efficient LMS under b-learning mode.
- *Alternative approaches to education field*: the efficiency of the presented FuzzyQoI scheme, intended to understand the trends and dynamics within the interaction quality, justifies the adoption of fuzzy logic in the field of education, while at the same time, motivates and prepares the way for an alternative approaches of the LMS Moodle modeling for b-learning modalities. To this end, intuitionistic fuzzy sets and neuro-fuzzy modeling could also be attempted towards the realization of *i*LMS.
- *Efficient assessment techniques*: apart from the educational feedback managerial implications could also be tracked through the use of QoI; in fact, LMS managers/designers could include the measure of QoI (from all users' categories, i.e., students and professors) and via the latter reflect upon issues like system-quality, system-use and user-satisfaction into their present evaluation techniques of LMS-based b-learning systems efficiency. This evaluation would provide a fast and early feedback to the academic institutions to enhance their understanding of the level of online learning systems efficiency and take corrective actions, if necessary, for improvement at a more administrative level.
- *Applicable across multiple b-learning contexts*: due to the worldwide adoption of LMS Moodle in the educational practice, the related issues discussed in this

book could be applicable across a broad spectrum of b-learning, and in general e-learning, systems, providing a common approach for comparative critical analysis. To this end, the efficient scaling and reliability on the basis of analyzing data from a sample of the FuzzyQoI scheme, allow the framework, when necessary, to be adapted or supplemented to fit the specific practical needs of a particular OLE.

- *Inclusive scenarios*: the exploration and integration of more inclusive approaches and universal instructional design principles, specially tailored to the needs of the LMS Moodle users, focused on technological and pedagogical improvements and advances, is mandatory.
- *Blending as a state of mind*: this book clearly contributes to the development of an *i*LMS based on conceptual blending as a creative thinking; the blended concept, although successfully applied in a varied number of fields, has to be examined in a more understandable and detailed way, (re)combining particular elements and their relations into a common sociocultural space to generate new inferences and new relations in further advances in OLEs.
- *Mobile alternatives*: the combination of the MOOCs perspective in the education and the use of mobile technologies (e.g., Google Glasses) it is a promising solution in the scientific investigation for innovative OLEs.
- *Affective learning*: the extension of OLEs to the field of affective computing seems imperative, since emotions have been recognized as an important component in motivation and learning. In this vein, modeling of students' emotions by intelligent tutoring systems could provide more personalized, adaptive and intelligent instruction to the learner.

In summary, considering the aforementioned standpoints, it seems reasonable to assume that b-learning environments (systems) can contribute to creative learning approaches, promoting efficient OLE instruction processes, in particular with the use of the LMS Moodle, and blending theoretical concepts with practical implementations towards a more pro- and inter-active *i*LMS. With the use of the latter, adaptive learning environments can be realized, offering substantial support for the instructional process through adaptive guidance and personalized online and open learning resources. In general, an *i*LMS can be seen as more advantageous for HEIs and, in turn, more advantageous for the (e/b/m/u/LL-) learners.

13.3 Focused Further Research

The contributions of this book clearly reveal a way forward for future research, especially for researchers concerned with the educational process in b-learning systems. B-learning shares with other educational aspects the problem that, because it is social and includes a wide range of educational sources, it inevitably embraces a handful of variables. From an initial approach, this precludes the application of quantitative evaluation. As it was shown in Chap. 10, however, by

employing alternative approaches (such as fuzzy logic) within the modeling scheme, it is possible to develop new models that take under consideration the human factor and the complex nature of b-learning, resulting in a quantitative evaluation, as expressed by the quality of interaction parameter.

When probing to the future from the aforementioned motivation, some additional research issues could be considered, i.e.:

- *CMS effect analysis (Differentiation)*: in the presented work, actually, five different courses involved in the testing data were unified; however, a course effect analysis can be performed and associated with the estimated FuzzyQoI outputs, so to examine how the course content affects the users' QoI.
- *Behavior analysis to each single user (Personalization)*: the degree of contribution of each interaction characteristics and perceptions to the students' learning outcome, combined with their QoI level, could also be examined.
- *Subsequent academic years analysis (Follow up)*: since the data used here refer to the LMS Moodle usage from one year only, and particularly the first one, the FuzzyQoI could also be applied to similar data from consequent academic years, revealing possible macroscopic causal dependencies, converged or dispersed interaction trends, periodicities, specific patterns dominance in the interaction attitude, all reflected at the FuzzyQoI model response. This would contribute to a more objective interpretation of the way LMS Moodle-based b-learning functions within the higher education curriculum.
- *Transferability/adaptivity at other level of education (Validity generalization)*: the flexible structure of FuzzyQoI scheme allows its transfer to other educational contexts, like secondary education; realization of this transfer could contribute to further validation of the FuzzyQoI model efficiency in transferability and adaptivity to accommodate with the differences within different educational settings that utilize LMS Moodle-based b-learning.
- *Comparative analysis (Hybrid approaches)*: a comparative performance analysis of the forthcoming intuitionistic fuzzy model, the neuro-fuzzy model and the FuzzyQoI model would allow for hybrid modeling approaches, blending the benefits of each one.

13.4 The Ultimate Taste

From a more general perspective, it should be noticed that there is growing awareness in HE of student levels of engagement in Web 2.0 environments, in contrast to their engagement in the LMSs hosted by their institutions. Social networking sites, blogs, and wikis offer students unprecedented opportunities to create and share content and to interact with others. These sites are used regularly by the majority of students (Hoare 2007) and provide possibilities for customization and a sense of ownership currently impossible in LMSs. Lecturers

increasingly complain of the distractions caused by the dynamic and compelling social networking sites their students use during lectures. By contrast, it has not gone unnoticed that even the term LMS suggests disempowerment—an attempt to manage and control the activities of the student by the university.

Most learners are entering universities with increasing experience of the online world and competence in using social software in their leisure (or professional) activities. It has been suggested that learning providers cannot hope to compete with the developments that are happening so rapidly elsewhere on the Internet and that students will consequently find LMSs and the tools within them inferior to those they are already using freely on the Internet—both in their look and feel and in the amount of functionality offered.

Moreover, there is continual pressure on HEI computing service departments to make available familiar open source tools such as MediaWiki (the wiki system behind Wikipedia) and WordPress (a popular blogging system). These tools are feature-rich and already in use by many faculty who are often highly technically literate, visionary, influential, and prepared to make their opinions known widely in the blogosphere and elsewhere. They point out that the facilities in the LMS are more limited, and they either use these tools freely on the Internet or ask why the institution does not simply provide these systems for teaching and learning alongside the LMS. Even when the institution agrees to host such facilities, it can take a frustrating amount of time for the software to be installed, customized, and integrated with existing systems, and its use may be restricted in ways deemed unsatisfactory to teachers.

Much of the debate regarding the shortcomings of LMSs is taking place in the blogosphere, and a good deal of it centers on the concept of a personal learning environment (PLE) (Sclater 2008). Proponents of PLEs agree that there is a need to harness the power of a range of tools, services, and content outside of the institution that learners can use during their studies. Effective online learners know how to make the most of the services available and may resist further client software to mediate on their behalf. There is strong evidence that students now see the personal computer as their primary learning tool, and this can be regarded as a *de facto* PLE (Conole et al. 2006). Research demonstrates that learners are increasingly comfortable switching between a wide range of tools and sites, making simultaneous use of locally installed applications, books, and the Internet, and participating in a variety of online and F2F communities of practice. Proponents of PLEs, motivated by a lifelong and informal learning agenda outside the boundaries of current institutionalized education, attempt to position PLEs as a replacement for LMSs.

Looking at the typical LMS embedded within this challenge, its robustness could be approached through the notes of Milligan (2006), who characterizes LMS as a conservative technology for managing groups, providing tools, and delivering content. Given that formal education remains in strong demand from learners, is supported by governments throughout the world, and is unlikely therefore to disappear in the near future, there will continue to be a need for online systems that provide administrative functionality, such as allowing students to register and pay

for courses, and provide information, such as course descriptors, syllabi, reading lists, class times, examination dates, and results. Centrally hosted systems are also required for the submission and marking of assignments online—and the return of marked scripts to students. LMSs can be used to restrict access to content and services for those enrolled in the course and to group learners together with the teacher allocated to them, encouraging frequent contact throughout their studies with a single set of robust communication tools. The correct list of online contacts for the course should be set up automatically for the student in the LMS. This is already a considerable challenge for institutions responding to late registrations, and it would be an unacceptable burden on students if there were no data transfer between student record systems and online learning systems.

Moreover, the real costs of supporting multiple "free" online learning systems, whether hosted in-house or externally (usually funded by advertising) are regularly underestimated. Most universities have built up considerable expertise in their LMSs and the ability to keep on top of the developments happening to those products. It would be a complex task for information technology and computing service departments to maintain a similar understanding of a broader range of open source products, their functionality, code base, and release cycles. There is also resistance from many of the less technically literate faculty (and some students) to being expected to use multiple systems with varying interfaces.

Furthermore, offering products with widely differing user interfaces that have not been checked for accessibility and usability may be inadvisable. The integration possible in a single LMS allows a forum contribution or a blog entry to be transferred instantly to the e-portfolio, for example, or a term appearing in the glossary to be highlighted within the forum, blog, quiz, or any other module. Achieving such integration across multiple, continually evolving systems would be a highly complex and costly software engineering task. In addition, with an LMS, there is no need to replicate user's databases or access permissions across multiple systems, and the user need authenticate only once. Finally, it is far easier to track usage from the single database of an LMS than to have to trawl for data through the databases of multiple e-learning systems—and this may be impossible if the systems are externally hosted.

Objectively, any educationally useful feature of a Web 2.0 system can potentially be incorporated into an LMS, although the smaller cohort using it (based around an institution or a course rather than a global set of users) may restrict its usefulness. The key question is not whether LMSs can or should evolve into collections of the social software tools found elsewhere on the Internet but *what is the most appropriate context of use for the learner at that particular time?* A student in a software engineering course might use a university-provided wiki for tasks relating to that course, a proprietary wiki for collaboration with colleagues in their workplace, and Wikipedia for leisure pursuits. These systems are likely to differ at the functional and user interface levels. Effective wiki users know the basic features of a wiki, however, and should be able to master a new wiki system rapidly. Bringing these different arenas together via a mediating interface may have some value for the learner, but will not always be necessary or appropriate

and may result in a lowest common denominator of functionality. It is possible that the LMS will evolve into more of a management information system, working away in the background, with its information exportable to a variety of other systems under the control of students who wish to view it in environments they prefer. LMSs may, therefore, increasingly have to allow data to be exported to and imported from other systems. There is likely to be a core set of functionality, however, that the HEI will have to continue to provide for the reasons described earlier, including for the many faculty and students who prefer to access learning and administrative content via consistent, simple, institutionally hosted systems.

In fact, LMSs need to be able to support the concept of sub-courses, such as tutor groups, and meta-courses in which learners can be enrolled in addition to their individual courses. Students may have finished one course and not be ready to start the next one, but they still wish to be part of a subject community, retain contact with other students, and continue to have access to domain content. These groupings are very much under the control of the HEI, which may not always be able to put students together in the best way or allocate the appropriate tools to them. LMS will increasingly need to be accessed offline and will require associated client software. In addition, students will expect access to educational content and services via devices, such as mobile phones; LMSs must therefore present content acceptably on small screens, and institutions will have to design content with this in mind.

Moreover, there are emerging attempts to integrate LMS functionality with social networking systems, such as Facebook or Twitter. These concentrate either on drawing information out of Facebook and into the LMS or providing LMS facilities inside Facebook. The latter is a more popular option, because it is believed that if students are highly engaged in that environment, it makes sense to provide them with educational facilities in the medium where they feel most comfortable. However successful these experiments may be, it is evident that some students do not necessarily want their education—which they may see as quite a separate part of their lives—to mix with their social environment. Moreover, while learners will continue to use the environments they find most engaging and useful, institutions need to be careful that they do not lose the opportunity to track what students are doing. If they fail to record valuable data on how students are using learning tools and content, it will be far more difficult to enhance the courses (based, for instance, on the estimated QoI) and provide remedial assistance to learners with difficulties and/or disabilities.

In a wider sense, LMSs could be extended to support the remote learners in various situations, mobile or fixed (ubiquitous (u-)learning). This means the incorporation of a great variety of communication channels, such as Web, email, SMS, phone call, and a large range of scenarios of use, where channels are combined in a same unit of interaction depending of the context. In the latter, not only information about the technological and physical contexts of interaction is captured, but also the user's profile, the nature of the activity and its history. In this way, the learning system is factorized into a collection of dedicated e-services and the user's interactions with the channels can be abstracted with a channel

independent modeling language. The management of these intermediations could be achieved through a multi-agents infrastructure combining several sources of contextual knowledge, especially for the dynamic orchestration of the e-services.

Returning to the roots of this book, yet equipped with the knowledge of its journey, it is time to reflect upon the following question that emerges:

Can the LMS survive in a world where workplace learning is about more than taking prescribed courses, a world where much learning comes via *our interactions with others?*

To address the above question it should be understood that *people* are indeed what learning is all about. It is only in the past few years that technology has been able to begin to catch up with this truth, thanks to the power of social networking over the Internet. In this perspective, the concept of *cloud computing* could be adopted here to support learning across the four contexts of the formal, non-formal, on-demand and experiential. In this sense, the *i*LMS must support the learning experience rather dictating it, exhibiting—among other things—a genuine social focus and mobile delivery capability. At the same time that the range of Web 2.0 tools for teaching and learning is increasing on a daily basis, the LMS market is also rapidly changing. In particular, two developments, open source computing and the aforementioned cloud computing, are resulting in a stream of new entrants to the market with different business models and value propositions. Some indicative examples include *Canvas by Instructure* (www.instructure.com), Pearson's *OpenClass* (formerly Learning Solutions) (www.openclass.com), *LoudCloud* (www.theloudcloud.com), and *Schoology* (www.schoology.com/). In essence, these newer LMSs enable instructors to by-pass the institutional infrastructure and manage the LMS environment themselves.

In a deeper approach, as a radical argument, the representation of LMS itself could be creatively questioned, in the sense that "Learning Management System" implies a system that manages learning. Nevertheless, learning happens inside people's heads, and it is a process that can be supported and stimulated, but not managed. Actually, a LMS is a system with some context. People use this to make sense of the issues they face and then learn and do their work better. Perhaps, a more pragmatic correspondence of LMS could be "Learning to Make Sense". Actually, technologies are needed to support learning today. They can be bought packaged in a single, centralized system, or can be assembled by ourselves and integrated as much or as little as wished. They can be our learning management system, our personal learning environment, or our knowledge network. Whatever we call these tools and systems, the key thing is what they do; properly implemented, they help us make sense of the issues we face, and learn better as a result. Nevertheless, it should be kept in mind that learning has its own needs for dedicated and fully adjustable support in all levels, i.e., from prep to classroom all the way to results via a dedicated learning transfer strategy involving key stakeholders. Indeed, the LMS is an instructor- and institutionally-controlled tool. It tends to support best a traditional approach to teaching based on the control, management and transmission of information by the instructor to the student.

Nevertheless, in the 21st learning, it is a need to move away from thinking of a LMS as a complete "course in a box", but rather as one tool in a more complex digital or virtual learning environment, where LMSs exist alongside and are integrated with a wider range of technologies. These learning environments will be customized or personalized according to the needs of both instructors and students. Thus, technology needed to be seen as a range of tools, which will be used in different combinations for different tasks. Both instructors and students will have a certain amount of freedom to work within such a virtual learning environment. Students will be able to customize their screens to meet their personal learning needs; different instructors will have a different look and feel to their virtual learning environments. Some instructors, however, will still prefer the comfort of a heavily structured learning environment and will be more than happy to exist "within the box" of an LMS. Eventually, all HEI will move increasingly towards a hybrid learning model, consisting of both campus-based and online instruction. In such an environment, it will be helpful, both for instructors and students, to have a virtual learning environment that will help them manage their teaching and learning, whether on-campus or online. Conversely, these learning environments will vary depending on the individual needs of instructors and students.

Given the inexorable development of new technologies and their growing importance within our lives, it is not really possible to isolate the HEIs from the changes going on all around it. ICT and teaching will continue to bounce off one another over time. Technology feeds and amplifies this trend towards change. These changes are not necessarily good (or bad), but HEIs, instructors and students do need strategies to prepare themselves for a continuously and rapidly changing environment for teaching and learning.

Naturally, choice is good, but criteria for making good decisions are also important. It is clear that the choice of technology is better made when instructors have strong frameworks based on how they want to teach and the learning outcomes they wish to achieve. As it was shown in the case studies of this book, teachers' ICT knowledge and LMS training were quite inadequate and they were often unaware of features that they were seeking that were actually within the LMS. The wider the choice grows, the more important faculty development and training will become, combining both pedagogy and technology awareness and skill levels.

As a bottom line, it is realized that new developments in Web 2.0 technologies have major implications for teaching and learning and, in particular, offer opportunities to develop the skills and knowledge needed in the twenty first century learning. These developments are leading to major changes in the LMS industry with a move towards more open learning environments that integrate new Web 2.0 technologies as they become available. The end result is likely to be the creation of online managed learning environments that will support a wide range of teaching and learning, including the F2F component of teaching, within the b-learning context. To manage the constant change and development that we are likely to see over the next few years, not just in the application of new technologies to learning, but in the overall approach to teaching, HEIs will need to have in

place clear strategic directions. If innovation is to be a key strategy, then HEIs will need to have in place strong governance mechanisms for decision-making around the choice and use of technology, to ensure consistency and quality, while allowing as much freedom as possible for instructors to choose the technologies and learning environments that best fit the needs of their students.

In brief, current changes in learning technologies are ushering in an exciting era of development in teaching in higher education. In this context, this book aimed to help institutions, instructors and students take full advantage of this opportunity, presenting a shifting trajectory from typical to intelligent LMS; it is our hope that this goal has successfully been accomplished.

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Hoare, S. (2007). Students tell universities: Get out of MySpace! *The Guardian*, Nov 2007. http://www.guardian.co.uk/education/2007/nov/05/link.students

Milligan, C. (2006). The road to the personal learning environment? CETIS, Bolton, May 2006. http://www.cetis.ac.uk/members/ple/resources/colinmilligan.pdf

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Appendix A
List of Institutional Websites

Websites of:

Open Universities

www.athabascau.ca
http://www.noun.edu.ng/
http://www.out.ac.tz/
www.oscail.ie
http://www.eap.gr/
http://www.uninettunouniversity.net/portal/it/default.aspx#
http://www.ouc.ac.cy/
www.open.ac.uk
www.ou.nl
www.open.ac.uk
www.ou.nl
www.uned.es
http://www.aiou.edu.pk/
http://www.qou.edu/englishIndexPage.do
www.anadolu.edu.tr/en/
http://www.bou.edu.bd/home.php
http://www.btvu.org/enbtvu/index.html
http://en.crtvu.edu.cn/
http://www.capcow.com/
http://www2.upou.edu.ph/
http://www.braou.ac.in/
http://www.ignou.ac.in/
http://www.bhojvirtualuniversity.com/
http://ycmou.digitaluniversity.ac/
http://www.knou.ac.kr/engknou2/
http://www.ru.ac.th/newRu/index.html
http://www.stou.ac.th/applystou/index.htm

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http://www.scs.cuhk.edu.hk/cuscs/tc/index.php
http://www.ouhk.edu.hk/WCM/?FUELAP_TEMPLATENAME=tcSingPage&lang=eng
http://www-e.openu.ac.il/
http://www.ouj.ac.jp/eng/index.html
http://www.ut.ac.id/
http://www.wou.edu.my/
http://www.opencolleges.edu.au/opencolleges.aspx
http://www.openpolytechnic.ac.nz/

Institutions Focusing on DE

http://www.asu.edu/
http://www.iub.edu/index.shtml
http://www.worldcampus.psu.edu/?CID=ICD28207
http://www.esc.edu/
http://www.ahlei.org/
http://www.dce.ufl.edu/default.aspx
http://www.umuc.edu/visitors/about/
http://www.phoenix.edu/
http://www.teluq.uquebec.ca/
http://www.tru.ca/
http://www.ubc.ca/
http://portal.estacio.br/
http://www2.unopar.br/about_unopar.htm
http://www.unam.mx/index/en
http://www.udgvirtual.udg.mx/portal_suv/
http://www.unc.edu.ar/
http://www.ubp.edu.ar/
http://www.umng.edu.co/www/section-4663.jsp
http://www.open.uwi.edu/about/welcome-uwi-open-campus
http://www.maseno.ac.ke/index.php?option=com_content&view=frontpage&Itemid=1
http://www.ntinigeria.org/
http://www.ub.bw/
http://www.unisa.ac.za/default.html
http://www.fernuni-hagen.de/
http://www.eng.muh.ru/?user=09c66fc40a646ffdb71c1441e41e01bd
http://eng.mesi.ru/about/
http://www.cned.fr/
http://dsv.su.se/en/
http://www.uab.pt/web/guest/home
http://www.eng.unibo.it/PortaleEn/default.htm

http://www.fernuni.ch/
http://www2.le.ac.uk/study/ways/distance/
http://www.aeu.edu.my/
http://www.crdenet.net.cn/about.htm
http://www.bau.edu.lb/
http://www.hbmeu.ac.ae/en/home/
http://www.imaonline.in/index.aspx
http://www.nams.org.in/
http://www.scdl.net/scdl/
http://www.mu.ac.in/idol
http://www.du.ac.in/index.php?id=4
http://www.pnu.ac.ir/Portal/Home/Default.aspx?CategoryID=018b76d4-5bf1-47b2-88cc-d5a15da7cf68 http://www.ut.ac.ir/en
http://www.unisim.edu.sg/
http://www.saidi.edu.ph/about_us/about_saidi
http://www.pu.edu.pk/
http://www.massey.ac.nz/massey/home.cfm
http://www.une.edu.au/
http://www.usq.edu.au/
http://www.usc.edu.au/
http://www.qut.edu.au/

Virtual Universities

http://www.cvu-uvc.ca/
http://www.avu.org/
http://www.vhb.org/en/homepage/
http://www.e-ope.ee/
http://www.nki.no/nettstudier/nki-nettstudier-scandinavia-s-largest-provider-of-online-education
http://www.puw.pl/
http://www.uoc.edu/portal/english/index2.html
http://222.122.208.132/english/about_founding.asp
http://www.vu.edu.pk/

Consortia

http://www.adec.edu/
http://www.calstate.edu/
http://www.cread.org/
http://www.cuny.edu/index.html

http://www.northcarolina.edu/
http://www.passhe.edu/Pages/default.aspx
http://www.tamus.edu/
http://sloanconsortium.org/
http://www.ohiohighered.org/
http://www.wisconsin.edu/
http://www.contactnorth.ca/
http://www.ipn.mx/
http://norgesuniversitetet.no/
http://www.london.ac.uk/
http://www.euromime.org/
http://www.gujaratuniversity.org.in/web/WebComplete.asp
http://www.uitm.edu.my/index.php/en/home
http://www.dehub.edu.au/summit2011/index.html
https://www.open.edu.au/public/home

Appendix B
Survey

General Theme: The use of the LMS Moodle in the Faculty of Human Kinetics.

Aim: To collect information about the use of the LMS Moodle in the 2008-2009 academic year, according to the students' perspective.

Mode: Online survey.

PART I

I.1. Some introductory notes

This short survey incorporates part of a research study in the Educational field, about online learning environments, specifically the LMS Moodle, in the context of higher education.

All responses will be kept confidential.

This online survey is organized into 5 Parts and includes 11 main questions/categories.

Thanks for your precious participation and collaboration.

I.2. General information about the respondents:

I.2.1. Gender

I.2.2. Age

I.2.3. Email

PART II

(Please use the following scale to indicate your degree of agreement with each item: 1-Agree; 2-Agree more than Disagree; 3-Disagree more than Agree; 4-Disagree)

II.1. LMS Moodle Usability

II.1.1. It is easy to learn and use the LMS Moodle.

II.1.2. It is simple and intuitive to use this system.

II.1.3. Overall, I am satisfied with how easy it is to use this system.

II.1.4. It is easy to find the necessary information I needed.

II.1.5. I am able to efficiently complete my work using this system.

II.1.6. The interface of this system is pleasant.

II.2. LMS Moodle Communication Tools

They allow users to:

II.2.1. Choose alternative tasks.

(continued)

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(continued)

II.2.2. Promote knowledge sharing.
II.2.3. Promote technological innovation.
II.2.4. Develop digital skills.
II.2.5. Promote collaboration and personalization.
II.2.6. Reinforce individual engagement.
II.2.7. Develop social and learning skills.
II.2.8. Develop personal skills.
II.2.9. Develop transversal competences.
(Note that: To answer the next question (II.3), please select Yes or No.)
II.3. What Type of Tools/Activities did you use in the LMS Moodle?
II.3.1. Chats
II.3.2. Discussion forums
II.3.3. Glossaries
II.3.4. Online tests/quizzes
II.3.5. Wikis
II.3.6. Emails
II.3.7. Debates
II.3.8. News
II.3.9. Other:

PART III
(Please use the following scale to indicate your degree of agreement with each item: 1-Agree; 2-Agree more than Disagree; 3-Disagree more than Agree; 4-Disagree)
III.1. What is the teachers' role/responsibility in the LMS Moodle?
III.1.1. To motivate students to the use of the system.
III.1.2. To provide activities taking into account the interindividual differences.
III.1.3. To promote collaborative online tasks.
III.1.4. To enable effective information sharing amongst all users.
III.1.5. To encourage online activities involving peer collaboration.
III.1.6. To stimulate the autonomous work.
III.1.7. To take into account the individual students' learning pace.
III.1.8. To stimulate the creative and reflective thinking.

PART IV
(Please use the following scale to indicate your degree or agreement with each item: 1-Agree; 2-Agree more than Disagree; 3-Disagree more than Agree; 4-Disagree)
IV.1. How you would describe your role (as a student) in the LMS Moodle?
IV.1.1. I have interacted creatively with the LMS Moodle.
IV.1.2. I have worked collaboratively in the online environment.
IV.1.3. I have chosen critically online tools/activities.
IV.1.4. I have effectively communicated with other users.
IV.1.5. I have autonomously selected my online tasks.

PART V

(Note that: To answer the next question (V.1.), please select Yes or No.)

V.1. Did you need to use other communication tools?

V.1.a. Yes

V.1.b. No

(Note that: If, in the previous question, the answer was "Yes" please go to V.1.1. question. If your answer was "No", the survey is complete.)

V.1.1. Which?

V.1.1. a. Chat

V.1.1. b. Videoconferencing

V.1.1. c. Discussion forum

V.1.1. d. Glossary

V.1.1. e. online test/quiz

V.1.1. f. Email

V.1.1. g. Debate

V.1.1. h. New

V.1.1. i. Wiki

V.1.1. j. Other:

V.1.1.1. For which purpose?

Thank you for your time!

Appendix C
Interview Planning Guide

General Theme: The use of the LMS Moodle in the Department of Sciences Education of the Faculty of Human Kinetics.

Aim: To collect information about the teachers' instructional practices in the use of the LMS Moodle, in the 2008–2009 academic year.

Mode: Semi-structured and audio-recorded interview.

Part A - Introduction key components (~5 minutes)	
Analysis' dimensions	Guidelines
Presentation	**A1.** Presentation of the researcher and interviewee.
Purpose Confidentiality Duration How the interview will be conducted	**A2.** Information about study's main purpose and how the interview will be conducted. **A3.** Information about the study's aims, i.e.: characterization of the OLE with regard to usability issues, communication tools available in the LMS Moodle, as well as the teachers' and the students' role in the OLE.
Opportunity for questions	**A4.** Clarifications about the interview's contours, namely:
General information	A4.1. the interview will have the duration of +/−1hour; A4.1.a. anonymity of the interviewee will be guaranteed, i.e., all responses will be kept confidential; A4.1.b. an authorization to perform an audio-recorded interview will be requested; A4.1.c. the possibility to share the conclusions of the study.

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Part B – Development (~50 minutes)	
Analysis' dimensions	Guidelines
Usability Issues	**B1.** How did you usually interact with the LMS Moodle? Please explain.
Communication Tools	**B2.** How did you find the interface of the LMS Moodle? How intuitive and helpful you found the navigation system?
Type of Communication Tools	**B3.** What instructional strategies and tools were used in the LMS Moodle? Please provide a justification for your response.
Teachers' Role	**B4.** Which of these strategies, activities and tools would you consider to be key elements? Why?
Students' Role	
Future Steps	**B5.** Specifically, what kind of communication tools/activities did you use in the LMS Moodle? (synchronous and/or asynchronous) Please list.
	B6. What is, in your opinion, the teachers' role/responsibility in the LMS Moodle? Why?
	B7. What would you do differently in the LMS Moodle? Why?
	B8. What pedagogical/institutional strategies would be re-appreciated? Why?
	B9. What is the students' role in the LMS Moodle? Please elaborate.
	B10. What recommendations do would you give for future initiatives?

Part C - Closing key components (~5 minutes)	
Analysis' dimensions	Guidelines
Additional comments	**C1.** Is there anything else you would like to add?
Thank the interviewees	**C2.** I will analyze the information that you gave me and I will be happy to send you a copy to review, if you are interested.
	C3. Thank you for your time and collaboration.

Note that: the interviewee does not have to talk about anything that she/he does not want to and the interview may end at any time.

Appendix D
Interview Planning Guide

General Theme: The use of the LMS Moodle in the Faculty of Human Kinetics.

Aim: To collect information about the teachers' instructional practices in the use of the LMS Moodle, in the 2010–2011 academic year.

Mode: Semi-structured and audio-recorded interview.

Part A - Introduction key components (∼5 minutes)	
Analysis' dimensions	Guidelines
Presentation	**A1.** Presentation of the researcher and interviewee.
Purpose	**A2.** Information about study's main purpose and how the interview will be conducted.
Confidentiality	**A3.** Information about the study's aims, namely: to characterize the OLE with regard to LMS Moodle communication tools; to analyze the potential advantages of LMS Moodle; to identify the teachers' main concerns about the LMS Moodle use; and to understand teachers' expectations about the LMS use.
Duration	**A4.** Clarifications about the interview's contours, e.g.:
How the interview will be conducted	A4.1. the interview will have the duration of +/−1hour;
Opportunity for questions	A4.1.a. anonymity of the interviewee will be guaranteed, i.e., all responses will be kept confidential;
General information	A4.1.b. an authorization to perform an audio-recorded interview will be requested;
	A4.1.c. the possibility to share the conclusions of the study.

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Part B - Development (∼50 minutes)	
Analysis' dimensions	Guidelines
Type of communication tools/activities	**B1.** How did you usually interact with the LMS Moodle? How did you find the interface of the LMS Moodle?
Potentialities	**B2.** What instructional strategies and tools were used in the LMS Moodle? Please identify some of them.
Limitations	**B3.** Which of these strategies, activities and tools would you consider to be key elements? Please elaborate.
Constraints	**B4.** What worked well? Please justify your opinion.
Future Steps	**B5.** What can be improved? What would you do differently in the LMS Moodle? Why?
	B6. What potential advantages do you see in LMS Moodle? Please explain.
	B7. What pedagogical/institutional strategies would be re-appreciated? What external changes present interesting opportunities? Why?
	B8. What were the barriers, if any, that you encountered? What necessary expertise do you currently lack? Lack of technical support? Please list.
	B9. What obstacles did you face? How did you overcome the constraint(s)?
	B10. What effect, if any, do you feel the LMS Moodle had on the community in which you work?
	B11. What recommendations do would you give for future initiatives? If you could change something in the LMS Moodle, what would be at the top of the list?

Part C - Closing key components (∼5 min)	
Analysis' dimensions	Guidelines
Additional comments	**C1.** Is there anything else you would like to add?
Thank the interviewees	**C2.** I will analyze the information that you gave me and I will be happy to send you a copy to review, if you are interested.
	C3. Thank you for your time and collaboration.

Note that: the interviewee does not have to talk about anything that she/he does not want to and the interview may end at any time.

Appendix E
Interview Planning Guide

General Theme: The use of the LMS Moodle in the Faculty of Human Kinetics.

Aim: To collect information about the use of the LMS Moodle in the 2010-2011 academic year, according to the students' perspective.

Mode: Semi-structured and audio-recorded interview.

Part A - Introduction key components (~5 minutes)	
Analysis' dimensions	Guidelines
Presentation	**A1.** Presentation of the researcher and interviewee.
Purpose	**A2.** Information about study's main purpose and how the interview will be conducted.
Confidentiality	**A3.** Information about the study's aims, namely: to characterize the OLE with regard to LMS Moodle communication tools; to analyze the potential advantages of LMS Moodle; to identify the students' main concerns about the LMS Moodle use; and to understand students' expectations about the LMS Moodle use.
Duration	**A4.** Clarifications about the interview's contours, e.g.:
How the interview will be conducted	A4.1. the interview will have the duration of +/-1hour;
Opportunity for questions	A4.1.a. anonymity of the interviewee will be guaranteed, i.e., all responses will be kept confidential;
General information	A4.1.b. an authorization to perform an audio-recorded interview will be requested;
	A4.1.c. the possibility to share the conclusions of the study.

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Part B – Development (~50 minutes)	
Analysis' dimensions	Guidelines
Type of communication tools/activities	**B1.** How did you usually interact with the LMS Moodle? How did you find the interface of the LMS Moodle? Please explain.
Potentialities	**B2.** What activities and tools did you use in the LMS Moodle? Please list.
Limitations	**B3.** Which of these activities/tools would you consider to be key elements? Please elaborate.
Constraints	**B4.** What worked well? Please justify your opinion.
Future Steps	**B5.** What can be improved? What would you do differently in the LMS Moodle? Why?
	B6. What potential advantages do you see in LMS Moodle? Please explain.
	B7. What pedagogical/institutional strategies would be re-appreciated? What external changes present interesting opportunities? Why?
	B8. What were the barriers, if any, that you encountered? What necessary expertise do you currently lack? Lack of technical/ pedagogical support? Please list.
	B9. What obstacles did you face? How did you overcome the constraint(s)? Please elaborate.
	B10. What effect, if any, do you feel the LMS Moodle had on the learning community?
	B11. What recommendations do would you give for initiatives? If you could change something in the LMS Moodle, what would be at the top of the list?

Part C - Closing key components (~5 minutes)	
Analysis' dimensions	Guidelines
Additional comments	**C1.** Is there anything else you would like to add?
Thank the interviewees	**C2.** I will analyze the information that you gave me and I will be happy to send you a copy to review, if you are interested.
	C3. Thank you for your time and collaboration.

Note that: the interviewee does not have to talk about anything that she/he does not want to and the interview may end at any time.

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