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Creation of Virtual Reality for Education Purposes

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Abstract: Virtual reality systems have been developed primarily for the entertainment sector. However, they are being increasingly considered as high potential tools for use in industry and education. In this context, schools are now facing a challenge to introduce virtual-reality-supported teaching into their processes. With this in mind, the authors, in their paper, focus on the possibility for using virtual excursions as part of vocational education and training. For this purpose, they analyze the suitability and usability of selected virtual reality systems, as well as relevant camera systems, for the creation of virtual reality software products designed for industrial practice in upper secondary vocational schools' apprenticeships (vocational education and training). The main results of their analyses are summarized in the form of tabularized SWOT parameters.

Keywords: didactic tools; technology enhanced teaching and learning; virtual reality; augmented reality; 3D visualization; computer-generated environment; vocational education and training (VET); simulations; virtual excursions; virtual reality systems analysis; usability of virtual reality systems for education purposes

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1. Introduction

According to [1], three aspects have dominantly influenced education throughout its historical development. These are educational practice, educational research, and educational technology. Development of the then modern technologies of television and radio broadcasting and their introduction into the learning and teaching processes of the 1960s brought with them the phenomenon of technology-enhanced learning. The consequent introduction of personal computers in the 1980s took technology-enhanced learning to a higher level, which has been represented mainly by computer-assisted learning. In connection with this development, the given period is noted as the period of significant adoption of technology as educational means into teaching and learning processes, and at the same time, as the period of a broad establishment of the scientific branch of technology of education. As for the research subject of educational technology, this can be defined, in general, as the design of effective instruction methods supported by technological means, as the development of different ways to use various technologies to support education, and with that, as the handling of connected organizational and managerial issues. As the most outstanding element in the development of technology-enhanced learning, the Internet can be highlighted, particularly those applications which enabled the use of new forms of distance education.

Under the conditions of both the current world-wide globalization and the fourth industrial revolution, commonly named as Industry 4.0, national economies and societies, in particular, countries, are facing worldwide challenges to assure continued economic growth and sustainable competitiveness, and to rebuild their knowledge economies into digital economies [2,3]. To meet the stated challenges means to have enough appropriately educated and trained labour forces available on the labour market, characterized by the professional competences of the twenty-first century, allowing them to act within the space of these digital economies. Going further, to meet the call of the labour market for personnel equipped with professional competences relevant to the needs of digital economies, educational processes must be transformed appropriately at all levels. One of the key areas of this change represents the area of digital transformation in education to assure the sustainable quality of education in continuously fulfilling the constantly changing requirements of the modern world. Transformation of educational processes from so-called classical or traditional forms towards digital technologically enhanced forms becomes an important impetus for school systems all over the world. The stated requirement for the transformation of educational processes from the so-called classical or traditional forms towards digital, technologically enhanced forms should not be perceived only as a call for new goals, structures, and content of the concerned education, but it should be understood as a call for a complete change of the classical school environment. Digital transformation and globalization hits and will further hit educational institutions, affecting their study programs as regards both form as well as content. Technology, together with the widespread availability of Internet mobile connections, and the means of virtual reality are becoming some of the most powerful influences in today's educational scene. Educating the next generation of responsible technicians and engineers, graduates of secondary vocational schools and universities of science and technology, is the biggest impact these institutions have on society. In our point of view, an important part of each school environment is the didactic tools used; therefore, the schools face a task to manage the development of didactic tools which are good enough not just in the present, but which will also be meaningful and beneficial in the future.

The justification for the above-mentioned needs and requirements has been proven by the coronavirus pandemic [4–6]. A specific problem of the effort of schools within the first wave of the pandemic, faced mainly by secondary vocational schools, was the realization of the practical part of vocational education and training. Acquisition of professional skills and work experience at secondary vocational schools within the framework of practical training and excursions are key elements of apprentices' preparation for their further profession, job, or employment [7]. During the pandemic, the problem of transferring teaching processes from face-to-face platforms to online teaching platforms arose. However, this problem was relatively "easily" solvable compared to the question of how to ensure (online) implementation of professional training, including relevant excursions in the lockdown situation. In our opinion, virtual reality systems represent a useful means of eliminating the given obstacles faced by schools to assure the sustainable quality of professional education and training, and not only under the conditions of the coronavirus pandemic, but also in conditions of common life. Although these technology tools were intended for use in the entertainment industry, nowadays (also due to the impact of the coronavirus pandemic) they are gaining wider and wider acceptance in education [8,9], and support achieving sustainable development for humanity from education, through industry to its wellbeing.

One question to tackle is the question of the eventual use of some selected virtual reality systems for creating virtual excursions to replace their classical forms (or those which would allow for at least partial replacement of in-person excursions with virtual ones, and in this way, would support vocational education and training) [10,11]. Dealing with the stated question, we focus our attention on the possibility of using virtual reality (virtual excursions) in the frame of vocational education and training in Slovak upper secondary vocational schools. In the paper, the results of processed SWOT analyses are presented, to identify the most suitable virtual reality systems and related equipment that can be used for this purpose.

2. Review of the Current State of the Addressed Issue

Digital technology tools and the Internet have offered a platform for the implementation of virtual reality (VR) and augmented reality (AR) applications into common daily practice, including teaching and learning practice. Based on this platform, and within it, the created three-dimensional (3D) visualizations, a deeper understanding of the acquired subject matter through the multisensorial environment is reached [12]. Multisensorial environments are those that allow integration of more human senses [13], and learning objects enable visual transfer of knowledge that can be combined with teacher's explanations of the displayed images [12,14,15].

Thanks to the reality systems, one can experience being and moving in different environments that are designed and created by computers, and are supported by relevant graphics systems as well as by different relevant displays and interface devices. Likewise, thanks to virtual reality systems, teachers are given the option to choose different teaching methods and tools. What is most important is the fact that virtual reality promotes the development of learners' skills to analyze problems and investigate new terms, as well as knowledge. Virtual reality is a shareable platform where learners can interact with objects provided by the system. For users, it provides an interaction for which the following three steps are key:

- navigation—for moving and turning around one's own axis, or for moving through different spaces (3D environments),
- selection—for deciding the situation in which the simulation (the story, the crash simulation, the problem solving) takes place,
- manipulation—for handling different subjects used in the given simulation, either with the selected subjects or others.

An efficiency simulation is assessed according to the means by which a user can be put in such environmental conditions that are similar, or even the same as prescribed in the given script [16,17].

In the frame of different research studies and related discussions, researchers deal with the question of how the implementation of virtual and augmented reality products can influence learners and the changes it can cause or evoke in teaching and learning processes. There is no consensus on this issue, and the responses to the stated questions differ. However, following the increasing numbers of studies, more and more educational benefits of the use of virtual reality can be seen.

As for the phenomenon of virtual reality, recent research by Ausburn and her colleagues [18] proved that students engaged in engineering study programs supported by virtual reality tools showed high levels of motivation and they even had a significant tendency to devote their leisure time to learning. The same can be stated in relation to medical students. To them, virtual reality technology offers outstanding training support. In particular, for future surgeons, it is a fast, safe, and not so financially demanding method, or didactic means to be trained in the handling of various surgical situations [19–21].

An area in which the use of virtual reality has significantly increased during the last twenty-five years is experimental psychology. Much research has been done to analyze the impact of the use of virtual reality means on students' learning achievements. As for the advantages and disadvantages of the use of virtual reality means within the psychology students' preparation, the following advantages have been proven [20,22,23]:

- allowing greater control of the stimuli and more varied responses,
- making learning much more interesting, even exciting, with limited effort,
- allowing greater control of the stimuli and more varied responses,
- generation of different levels and combinations of multimodal sensory inputs that can be experienced simultaneously.

Using tele-immersion technology (immersion in the on-screen environment), it is possible to implement distance learning. With the help of special glasses and headphones, the learners are "embedded" in the room, which they see in spatial form, and have the impression that they are really there and that the teacher and teaching aids are right in front of them. A problem connected with teaching by means of this technology is the difficulty in carrying out the teaching in such a way that the teacher can see the audience directly in front of them and can respond to the learners' questions as quickly as possible. Another problem is the inability to encourage the learners as effectively as a teacher can in a real classroom when they see that the learners are not paying adequate attention. However, there are also other software products that can be used to implement virtual reality in teaching, e.g., the ROANS software, which offers the possibility of exporting the scene to the VRML (Virtual reality Modeling Language) format. This format, after further processing by special software, is presented by a head-mounted display in such a way that it induces in students the feeling of direct personal participation in an artificially modelled environment of a technological workplace [24,25].

One significant 3D project is the game Second Life, which takes the participants into a virtual world without any restrictions [26]. The virtual world is inhabited by real people resembling avatars, who can communicate with each other. Since its initial launch in 2003, the number of registered users has grown incredibly fast. Currently, there are approximately seven million users from all over the world. The moment you enter the virtual world, you are captivated by the vastness of the entire digital continent. There are many people and buildings, and you observe and gain different experiences from them. You can find a nice place where you can build your own house or headquarters for business. Each user (payer) can deposit real money into the game from his/her game account, which is converted into virtual money (so-called Linden dollars). With the virtual money, you can trade, which is highly valued. More and more companies pay for advertising space in this game, and even universities have entered this virtual world. However, it is not only universities that are growing their presence in Second Life. As Second Life grows, it provides more and more opportunities for learning. Paradoxically, it may even seem more suitable for learning than real life. People from all over the world, of different nationalities, religions, social status and so on, meet here. Communities of various interests are established here, where the exchange of knowledge and experience takes place more easily than in reality. Perhaps that is why more than 60 American universities are already experimenting with this environment. They include, for example, Montana State University, the University of Tennessee, Bali State University, Pepperdine University, Missouri State University, Bradley University, and others. This year, Harvard University Law School is also using Second Life for the first time. The virtual faculty takes the form of a real building. About 90 students are taking part in CyberOne's first online course, for which, they will earn real credits. It is a remarkable fact that this course is freely accessible to the public, so that students from far abroad, for example from South Korea and China, have also joined. Traditional distance learning systems use static web, video, and email. In them, communication with the teacher takes place mostly asynchronously (discontinuously). Unlike these systems, Second Life gives its users (learners) a feeling of real participation in a real classroom. The current level of computer graphics and animation allows an avatar to express feelings through different facial expressions. It must be mentioned that visual contact with classmates is very useful. Such contact allows learners to follow one another during work, for example, when developing a program, creating a model of a building, a molecule, and so on. However, teaching through avatars takes place a little differently than in school. For example, students can send personal messages to each other while working without disturbing others. Most experimental universities simply buy land and build their own virtual faculty. In addition to teaching spaces, students can also find a cafe, a bar, a dance hall, and a dormitory where they can take refuge without having to buy their own land [26,27].

3. Background of the Research

3.1. Virtual Excursions

In our case, the issue that we began to address after the coronavirus pandemic, was the problem related to the use of virtual reality in conditions of vocational education and training in Slovak upper secondary vocational schools. In particular, the question was whether it would be possible to substitute or support excursions included in apprentice training by the virtual form of these excursions. In traditional teaching, an excursion represents a form of teaching accompanied by a walk (e.g., through a production company or agriculture premises) [28]. According to the kind of the content of the excursion, attention during the walk (excursion) can be paid to historical, geographical, industrial, and agricultural phenomena. Such attention can be paid only to one kind of factor (monothematic excursion), their combination, or to the whole range of factors of the visited object (complex excursions).

A virtual excursion is based on the possibility of digitalized travelling offered by digital technologies. Digital and electronic travelling is an alternative to real travelling, during which, we remain physically in one location. With the support of multimedia, the Internet allows people to access new possibilities that give them a sense of freedom and of moving around the world [29,30].

Virtual excursions can be understood as simulations of a place, as sets of displayed images. There are several elements that enhance the virtual tour experience. Sound effects, voice translations, music, and content have a big impact on the success of the excursion. In current education, virtual excursions can become part of e-learning. The ability to join lessons from a remote location is considered the best alternative for those who cannot physically attend the remote location where the excursion takes place. Virtual tours are characterized by a general representation of a real place as a digital image. People like to visit a place to learn more about that place, its history, culture, and so on. Having this in mind, visiting a place is an ideal way to learn about it. Virtual tours offer viewers the possibility to see the given place without being there, simply by using such visual aids as computers and projectors. The advantages of virtual excursions in comparison to traditional physical excursions can be summarized by the following points [31]:

- First-hand (direct) learning—the most significant advantage the system offers is that virtual field trips offer a great place to learn. Students do not need to use regular textbooks to visualize and learn about the given place. Their acquisition of new knowledge is supported by the system that shows them the real place and teaches them things they would not understand just by reading.
- Price and cost reduction—this is an advantage mainly for students who cannot afford to spend the extra money on an actual field trip. In the case of a physical excursion, it is necessary to have enough money for travelling and also for accommodation in the given place.
- Safety and caution—besides higher costs connected with real excursions, another even more serious problem is that participation in physical excursions can even be risky and dangerous, e.g., excursions to dangerous environments (presence of toxic substances, radiation, etc.).
- Time—virtual tours are considered a great way to avoid travel fatigue. Under real conditions, when one reaches the destination of one's tour, it can take several hours and, when one gets there, one is too tired to learn anything. Virtual excursions reduce travel time to just a few minutes.

Virtual field trips represent a convenient way of learning. Although a virtual field trip does not bring the same pleasure as actually being present in the given place, it can broaden the range of possibilities to take the students for an excursion to bring the education by these educational tools closer to the practice [31,32]. Recent research has confirmed that one of the most effective strategies for improving communication, encouraging a greater initiative to learn, and understanding the importance of learning and the acquisition of new knowledge is precisely virtual interactions [33]. Social media, understood as tools to improve teaching and a means for enabling space for virtual excursions, is still at the beginning of its journey, and has great potential to become a transformative method of learning and teaching [34]. The use of social media in education can help increase the connection between a teacher and a student [35]. As Bailey and others state [36–38], the use of social media for learning is as important as the learning objectives, so they must have a social presence, include interactive learning, and encourage active, collaborative learning.

However even prior to COVID-19, the introduction of online teaching forms into education has presented issues that various experts have dealt with [39,40], pointing out different positives that these forms can have for the entire education process, as well as for the students' learning achievements [41,42]. In the context of language education, the benefits of the use of online forms of education were stated to be the possibility to carry out direct communication between the educators and learners, also including direct communication among the learners [36,43]. A very important phenomenon associated with online forms of education, partially regarding secondary school students but mainly regarding tertiary students, are social media and their use by these target groups. Hayes, Carr, Al-Rahmi, Wu, Pérez-López, and others [44–47] point out the benefits conferred by blog chats, if these are used as a complementary element supporting mutual interactions among the learners. They emphasize the influence of such led blogs on the development of students' ability to work together, to cooperate, to support each other, and to find creative solutions to the given tasks and assignments. In this way, utilization of social media, particularly blogs and chats, to support educational processes of the learners has impact also on development of students' motivation, cognitive skills and higher order thinking abilities. Keeping in mind this approach to social media, Bui et al. [48] characterized active collaborative learning as a process within which usually more than two learners are involved, and they try together to solve assignments and to acquire new knowledge.

One of the very important phenomena that has been stressed already for a long time is the necessity of the lifelong learning. The importance of lifelong learning has to be perceived not only from the point of view of the particular individuals but also from the point of view of their employers. Additionally, it is mainly employers who strongly appreciate online forms of education and their use for the further education of their employees. Moreover, at the same time, they appreciate the contribution of these forms to the development of their employers' ability to cooperate in teams [49,50].

The issue of the use of different social media hubs (e.g., MySpace, Facebook, Twitter) and their platforms (web 1.0, web 2.0) in the context of active collaborative learning has been the subject of different investigations and discussions [51–55]. As Al-Rahmi et al. [54] state, these means become a significant influencer of people's behavioral intention (including their learning intentions).

3.2. Implementation of Virtual Excursions

The implementation of virtual excursions is based on the capabilities of modern digital tools, e.g., 3D classrooms, virtual reality systems, computers, tablets, Internet, and Internet browsers. The digital tools commonly used to view the virtual excursions include Adobe Flash Player or HTML5 technology, which are available in Internet browsers. It is also possible to use gyroscopic control (device movement control) on tablets or mobile devices with iOS or Android operating systems. It is necessary to have a sufficiently fast Internet connetion, so that the image does not take too long to load and, thus, so that the experience of the virtual excursion is not lost. 3D stereoscopic technology is already used in schools for deeper immersion in virtual excursions. With the help of 3D stereoscopic technology, we achieve the "embrace" effect, when a person is literally absorbed in the virtual space of the examined object. This can be achieved in three ways, by the sufficient size of the projection area, the response of the system in real time, and the sufficient resolution of the system or device. The size of the projection surface should be such that an observer has the opportunity to completely "enter" the virtual space, and the surface should contain most of their viewing angle. The response of the system is important for the need to adapt the current display angle to the current position of the observer [56–60].

Panoramic photos or video are used to create virtual tours. Nature, architecture, and interiors all look very unusual in panoramic photos, thus increasing their interest for the viewer. The most attractive feature of panoramic photography is that the viewers have the opportunity to look around the place as if they were actually there. A panorama is a combination of several photos together, and it is possible to increase the resolution of a

3 Mpix camera to 20 Mpix. Panoramas are offered by a range of cameras as a standard service. We use panoramic photography wherever the shot does not fit into one frame, even when using the widest focal point available to us. Then, it is necessary to combine several images together using the recommended software. As a result, the photos can be joined together. Care must be taken to ensure that they blend well and that no deformations occur. The most suitable programs for creating panoramic photos are Gimp, Zoner Panorama Maker, Hugin, and Adobe Photoshop [61].

The weather must be taken into account if we want to include an outside virtual tour of the complex. Then, it is essential that the photography takes place in sunny weather. Sunny weather and blue skies evoke pleasant and joyful emotions, while cloudy skies or wet weather evoke mystery and sadness. During good daylight, especially, the details and the variety of colours of the surroundings are best captured. It is best to choose a time for outdoor photography when the sun is high in the sky, or the time before sunrise or after sunset, thus avoiding unnecessary reflections andd the need for their removal in post processing. There may or may not be people in the virtual tour. It is preferable if the virtual tour can be done without people passing by, which will help make better quality footage. According to Google's rules, human faces and license plates on cars must be blurred in photos. Blurring can be achieved using pixelation or blurring filters.

Before implementation, it is necessary to go through the entire space and think about where the photos will be taken, and how many photos will be needed so that the visualization can be created synchronously. A virtual excursion through the space copies natural corridors and creates a logical and smooth line through the space, just as in the real world. Natural corridors are imaginary places of people's movement. These are corridors, sidewalks, or free spaces between furniture in the case of interior shots. The imaginary connecting line or straight line between the two nearest photos (points) should copy these corridors and pass through doors when passing between rooms. Care must be taken that this straight line does not pass through walls or directly through objects. The distance between the two nearest points must not be large (1.5 m–3 m–5 m). It is acceptable that in exteriors or in larger rooms, larger distances can be chosen. If these principles are not followed, the points on the map may not match with the arrows that show direction in the virtual tour. It is very important that the photography device is horizontally aligned. If it is not level, the resulting photos will also be tilted to the side. The device should be placed at the height of an ordinary person's view (160–180 cm) [58,62].

As with classic photography, the the photography itself, the less time needs to be spent on editing. Of course, without any editing, the desired result will not be achieved. Some of the adjustments can also be solved when creating a virtual tour. However, it is best to edit them in advance and work with ready-edited photos when creating a virtual tour. Before and after the adjustments, the photos should be processed in a special 360 photo viewer, and it is important to pay attention to whether they contain faulty joints or distracting reflections. The maximum resolution of photos for Google Street View is 13,312 × 6656 px. Street View does not support higher resolution. Photos should be made in several versions with different ISO values. This method helps with the quality of the final photo, especially when capturing details in the interior. After exporting the photos, they should be set to one layer using an editing program. This step ensures that even dark places such as room corners or shadows are more visible. Of course, the opposite also applies; a photo taken in a darker interior does not capture the exterior environment or the view from the window, due to the large light differences. The procedure for creating a 360 video, which is recorded in the classic way, is a little different and more simple, where only a thorough preparation of the filming environment is needed, such as determining the position of the camera, the adjustment of the premises, and the most suitable location of the camera. Here, it is necessary to set an automatic ISO, which adapts to the changing surroundings. In the past, with the first 360 cameras, there were big problems with exporting videos and photos, as they were created as two separate files. They could not create a single, full 360-degree shot, and were only able to create two shots where each was 180 degrees. Ultimately, this meant that it was necessary to link these photos and videos using the metadata created along with the images and videos.

Currently, development of this technology has moved on and this step is not necessary, as the camera software can process it so that it can be used as a classic photo or video. While filming individual shots, one-minute segments are made, which are shortened to between 20 to 30 s in the processing step, as appropriate. The camera itself has several settings for the video format when exporting, with the most commonly used formats being .mp4 or .avi. The created video file can be exported from the camera not only to a computer for further processing, but also directly to a mobile phone. For better comfort and the possibility for more adjustments and settings, it is better to use a computer and a program that is aimed directly at video processing, in our case, Adobe Premiere Pro. In the Adobe Premiere Pro program, we know how to work with possible imperfections during video recording to a very high degree. This applies directly to exposure, finishing—colourization, adjusting unwanted noise in the sound, or replacing authentic sound with suitable music. Last but not least are labels, the so-called texts that are statically or dynamically inserted in the video, used as comments or titles, explanations above objects, or in their surroundings. When creating the virtual excursion itself, we must carefully consider the order in which the individual videos will be arranged to form a meaningful whole.

The final video export using Adobe Premiere Pro, which can be used universally not only on the Windows operating system platform but also on MAC OS, is most suitable at a resolution of 5760 × 2880 in the video format H.264 or H.265. Exporting the final product can take a few minutes to a few hours. This step depends on the performance of the device through which we process the video and the number of adjustments made, filters used, amount of text, transitions between individual frames, and others [58,63]. This file, which we can already name as a virtual excursion, is inserted at the end, and it is uploaded to the YouTube platform, where after publication, this virtual excursion can be forwarded, watched, and used in full. Publishing on the YouTube platform is dependent on the creation of an account and the creation of a channel. It is accessible to the public and requires compliance with the rules that each user and creator must agree to. The YouTube platform is the most suitable in terms of the unlimited number of published excursions, their length, and the quality in which the virtual excursion can be watched [64–66].

The tripod can be blurred or replaced with a logo or other graphic with the use of the Flexify plugin for Photoshop, which can transform the photo so that the floor—nadir is in the centre of the photo. On this transformed floor, we can work with a tripod as needed. Some manufacturers supply camera control and video processing software with their cameras. With the help of these programs, the creation of images without a tripod is enabled, with the option to blur, replace with the manufacturer's logo, our own logo, or with a classic black circle [66].

3.3. Virtual Tours through Google Street View and Social Networks

Google Street View is a part of Google Maps and Google Earth, which allows a view of streets in different parts of the world on all continents. Street View was firstly introduced in 2007 in the USA. It was initially accessible in San Francisco, New York, Las Vegas, Denver, and Miami. The project was successful, so the network of panoramic photos was expanded to include other places on Earth. Google also launched a new service that allows it to present companies, cultural monuments, nature reserves, and the like. Thanks to panoramic photos, users can go through interiors as well as exteriors. One can move to any place on Earth where the Street View function is available, with only the help of a computer, tablet, or mobile phone. 360-degree panoramic photos are used. Pictures are taken from specially modified cars that have unique cameras. The cameras are placed at a height of 2.5 to 3 m and record a full 360°. Special backpacks with cameras, snowmobiles, tricycles, or boats are used for hard-to-reach areas. In addition to the cameras themselves, each device contains a GPS for location recording and three laser sights that measure the distance in a 180° range in front of the car, up to a length of 50 m. Street View came to Slovakia in 2012.

Large and larger cities are fully monitored and there are also villages, but in their case, only images from the main road that passes through the village are available. There are also images from around the roads in the publicly accessible places of Slovakia's national gems, such as the Tatra National Park, the Pieniny National Park, or the Slovak Karst National Park. Google has also photographed the surroundings of Slovak lakes and water reservoirs, such as Zemplínska Šírava, Domaša, Liptovská Mara, and Gabčíkovo, and has also added new locations. Users can now walk through the High Tatras, Slovak Paradise, Orava Castle, as well as through five Slovak caves [67,68].

In the frame of teaching technically oriented subjects, students can see, for example, the interior and exterior of the Googleplex in Mountain View, California, and inside, one can see their data centre. Google has also launched googleartproject.com, where fine art lovers can browse galleries with a simple click of the mouse. This new service presents the most important works of art from 17 leading galleries in nine countries around the world. The project includes, for example, The Museum of Modem Art in New York, London's National Gallery, and the Museo Reina Sofia in Madrid. The site uses the aforementioned Street View technology and offers some works of art in super high resolution, with up to seven billion pixels. This allows visitors to see details that remain hidden to the naked eye [64,65].

In 2013, the Connected Classrooms project enabled Google to virtually visit many places in the form of museums, parks, and zoos. This project highlighted virtual field trips as saving class time and being less expensive than field trips. Through the Connected Classrooms project, Google connected entire groups of students in real time with a given place, supplemented by the Hangouts function, which enabled direct interaction between students and lecturers presenting in a virtual excursion. Students could enjoy experiences that they would otherwise not easily get, moreover, directly from their home or school environments. Virtual excursions are spaces offered by project partners such as the Seattle Aquarium, the Minnesota Zoo, or the mobile hangar of the Solar Impulse aviation project. There is expanding cooperation also with other partners, which means that the number of virtual excursions will increase [24]. In the context of the current world-wide globalisation and sharing of created teaching materials across different countries, a problem arising in relation to the use of virtual excursion can be the issue of their language modifications [69].

The situation that arose with the arrival of the COVID-19 pandemic caused the adoption of alternatives to traditional teaching methods. This was to ensure the protection of people from the spread of the disease, which subsequently resulted in the provision of new distance-based or online forms of studies. A formal education system had to be created with the help of electronic resources in the form of e-learning. Whereas teaching can be inside (or outside) the classroom, the use of computer technology and the Internet is the main component of e-learning [70,71]. In this way, e-learning as a replacement for classical teaching was the initial impetus for us to create virtual excursions that allow students to be in places and spaces that they could not otherwise access due to the spread of the pandemic.

Social networks are currently very widespread, and people commonly use them to communicate with each other. At the same time, they allow groups to be formed based on common interests. Social networks are constantly being enriched with new advanced functions in order to distinguish themselves from each other and attract not only users and companies, but also educational institutions. Social networks focused on adding photos and videos from vacations, trips, and the like are emerging. These give people opportunities to convey experiences from different places, or to show monuments, culture, and other points of interest from different locations. Social networks are also aiming to be educational, as many young people use social networks on a daily basis. They create projects for schools that are accessible only through social networks, via video calls, video recordings, and the like. Such social networks include, for example, Instagram and Google+.

3.4. Contribution of Virtual Reality Systems to Education

The benefits of the use of virtual reality in vocational education and training are the subjects of research activities carried out by many authors. The authors connect the observed and proven benefits with the fact that the use of these means has a significant impact on learning achievements, by consequence of the improved efficiency of the learning process, increased memory capacity, and creation of stimulating work conditions [23,72–75]. While reading a printed text, our brain is fully loaded, as it is processing the whole content of the read text. Contrary to that, while observing virtual reality, our perception of the presented content is limited to several observed pictures, which makes our understanding of the subject matter or knowledge more direct. In this context, two points should be stressed. One is the fact that the visualisation of any issue (presented subject matter, knowledge, systems, devices, processes, things to be learned, etc.) contributes to our deeper understanding of the presented matters and to the easier acquisition of the introduced and explained knowledge. The other is the fact that virtual reality also offers the possibility to ensure access to things and phenomena which, under normal common conditions, are inaccessible. For example, there is a collection of VirtualSpace worlds that aims to help children understand difficult non-intuitive physics concepts. Consisting of three virtual worlds so far, these three environments focus on concepts from mechanics and Newton's laws of motion (NewtonWorld), electrostatic forces and fields (MaxwellWorld), and the structure of molecules using different representations (PaulingWorld).

In general, being engaged in the presented virtual reality increases both students' learning motivation as well as their learning activity. Virtual-reality-based learning has been shown to increase learner attention levels by 100% and test scores by 30%. On the one hand, virtual reality changes the manner of our entertainment. On the other hand, its application into the area of education can completely change the methods of new knowledge acquisition in and out of school classrooms. Thus, the creators of educational (didactic) virtual-reality tools should be sufficiently familiarized with the principles of how to build and deploy educational programs that are well adapted to the technology of virtual-reality systems, and that also adequately fulfil the needs of learners to help prepare them for 21st century conditions [76–79].

4. Methodology of the Research

As stated above, as a consequence of the pandemic situation, we have, at our university, begun to deal with possibilities for virtual reality application development, which would enable at least partial replacement of personal forms of excursions with virtual forms, and which would, in this way, also contribute to or support vocational training.

As there are already many different virtual systems that can be used, the first task was to choose one of those available which would be the most suitable for our purposes. Moreover, the particular systems can differ in the technical level (category) they represent [80]. In general, four categories of technical professionalism are distinguished, which are basic, advanced, slightly advanced (semi-professional), and professional. An overview of three of each of these categories, is presented in Table 1.

The systems in Table 1 were selected based on their popularity in the field of 3D virtual tours, their availability, and their ease of use. Google Street View is currently a replacement for its predecessor, Google Tour, which Google decided to cancel in 2021. All features available in Google Tour have been transferred to Google Street View. As for the stated categories, the *basic group* of virtual reality systems contains programs with the simplest controls, whether for the target group of the end users (students) or for the target group of teachers as users. Into the group of *advanced systems*, we include systems that are not completely free of charge but are already charged by certain symbolic amounts, or have a more demanding user interface regarding the creation of virtual excursions. The category of *slightly advanced or semi-professional systems* is a group of systems that are more financially demanding and their prices far exceed the costs for systems placed in the group of *advanced systems*. These programs are the cheapest alternatives for companies that mainly deal with the presentation of real estate and their sale. They are demanding from the point of view of creating excursions, mainly due to the editing and post-processing, which places high demands on equipment. The last category of *professional systems* is represented by systems that are at a high level of processing, as well as from a financial point of view, where the services of these systems are purchased by large companies and corporations for their own promotion and presentation of their products. These programs also require higher processing power, which results in the higher quality of the products and materials created by these systems. In cases of unavailability or problems with the virtual excursion, they are equipped with HOTLINE services that can help a user solve their problems at any time.

Table 1. Overview of three virtual reality systems chosen in the particular categories.

Basic (for Free)	Advanced
➢ GOOGLE STREET VIEW ➢ THEASYS ➢ YOUTUBE	➢ ISTAGING ➢ KUULA ➢ MATTERPORT
Slightly Advanced/Semi-Professional	**Professional**
➢ CUPIX ➢ PANOSKIN ➢ GOTHRU	➢ PANO2VR ➢ KRPANO ➢ 3DVISTA

To decide which of the available systems represents the most appropriate choice for our intentions, a SWOT analysis of the available systems was processed.

The acronym SWOT, in the name of the analysis, which was used as the key methodology of our research, stands for Strengths, Weaknesses, Opportunities, and Threats, which are the basic elements of this method. Following the stated four basic elements of a SWOT analysis, SWOT analyses are usually presented as a grid-like matrix with four distinct quadrants—each representing an individual element. The method of SWOT analysis was originally developed for business and industry, but it is equally useful also in other areas of work, e.g., education, personal growth, health. It is a powerful means serving for evaluation and support in making both the right strategic plans and the right decisions. This means that the purpose of performing a SWOT analysis is to reveal positive forces that work together and potential problems that need to be recognized and possibly addressed. If one understands how to take stock of the strengths, weaknesses, opportunities, and threats, they are more likely to plan and act effectively.

In our case, the SWOT analysis was used as an excellent way to organize information we had gathered from different sources, studies or surveys.

The analysis was based on an assessment of three key aspects of the selected systems. One aspect was the technical capabilities offered by the particular present-day virtual reality systems, the second aspect was the opportunities for their didactic use in teaching, and the third aspect was the availability of these systems for secondary vocational schools.

Further SWOT analysis was processed in relation to selected camera systems. Of all commonly accessible systems, only five were analysed, a list of which, together with their technical parameters, is presented in Table 2.

Table 2. Technical parameters of the chosen camera systems. Source [81], own research.

Camera Type	Video Resolution	Photography Resolution	Device/Telephone Supp.	Battery Endurance	Memory	Waterproof + Dustproof
Insta360 One R	5.7 K 5760 × 2880 30 FPS	18.8 MP 6080 × 3040	Android, iOS	1 h	MicroSD	YES
Insta360 One X	5.7 K 5760 × 2880 30 FPS	18 MP 6080 × 3040	Android, iOS	1 h	MicroSD	NO

Table 2. *Cont.*

Camera Type	Video Resolution	Photography Resolution	Device/Telephone Supp.	Battery Endurance	Memory	Waterproof + Dustproof
GoPro Max	5.6 K 4992 × 2496 30 FPS	18 MP 5760 × 2880	Android, iOS	1–2 h	MicroSD	YES
RicohTheta Z1	4 K 4096 × 2160 29.97 FPS	20 MP 3840 × 1920	Android, iOS	4 h	Internal memory 19 GB	NO
Theta SC	FullHD 1920 × 1080 29.97 FPS	14.4 MP 5376 × 2688	Android, iOS	25 min	Internal memory 8 GB	NO

The SWOT analysis of the given camera systems was focused on reviewing their software accessories from the point of view of their suitability regarding the creation of virtual reality for specific educational purposes.

5. Summary of the Main Results and their Discussion

As stated above, the SWOT analysis of the twelve selected systems of virtual reality was evaluated based on their potential use in secondary vocational schools. As for the technical parameters, although they were assessed mainly from the point of view of their suitability for virtual excursion creation, at the same time, the possibility to use and share these creations over long-term periods was also taken into consideration. This approach logically leads to consideration of the financial demands of the given systems. As students are not expected to share the costs associated with either the creation or use of the created virtual excursions, we therefore tried to identify a compromising solution represented by the cheapest, but at the same time, still ensuring an appropriate high technical quality, technical system. In the case of some systems, there is the option of a one-time fee, and upon registration, all system functions are open for an indefinite period of use. However, only few providers of these systems operate in this way.

An overview of the main results of the SWOT analysis is summarized in Table 3.

Table 3. SWOT analysis of the selected virtual reality systems.

System Application	S—Strengths	W—Weaknesses	O—Opportunities	T—Thearts
GOOGLE STREET VIEW	- simple operation	- small number of inserted photos - small number of functions	- determination of visualization categories	- option of publishing completely or not at all (it is impossible to publish for a group of selected users)
THEASYS	- a number of functions - active cursors	- inserting five photos and five visualizations	- free publication of visualizations	- price 10 € for one visualization
YOUTUBE	- simple operation - all functions completely free	- the platform is accessible only for videos - long time for VR video approval	- creating your own channel for tours in VR	- absence of option to add a photo
ISTAGING	- simple operation - a large number of functions - colour categorization of visualizations	- inserting three photos and five visualizations	- compared to the competition for 200 € per year, everything is unlimited - quick export of visualizations - high quality visualizations	- price 200 € per year

Table 3. *Cont.*

System Application	S—Strengths	W—Weaknesses	O—Opportunities	T—Thearts
KUULA	- simple operation - name of the used photo displayed in the visualization - free publication of visualizations	- inserting six photos and 100 visualizations	- censoring the tripod - inserting your own logo	- the free version does not allow publication of visualizations - price 300 € per year
MATTERPORT	- displaying 3D space - measurement of distances in premises	- photo creation only through the Matterport 3D PRO device	- a number of professional functions	- video processing via online support (server) - price 2000 € per month
CUPIX	- simple operation	- an application designed primarily for the construction industry - limited options/functions	- high quality visualizations	- price 99 € per month - lengthy export of visualizations - demanding OS
PANOSKIN	- support from GOOGLE - VR READY support	- charging for all visualizations	- quick photo upload - adding photos and videos to the visualization	- price 249 € per year
GOTHRU	- replacement for Google Tour Creator - transmission of tours from GTC - a large number of functions	- complicated function control - inserting 30 photos and three visualizations	- publishing visualizations directly in Google Street View - compatibility with a large number of 360 devices	- price 209 € per month
PANO2VR	- simple operation - accessories for photo correction - designing own visualization elements	- demanding OS - the need to take photos only through the device	- integration into websites - connecting several visualizations - adding interactive elements	- Pano2VR PRO - price 999 € per month - Pano2VR PRO camera at a price of 2999 €
KRPANO	- preset tours - high photo processing	- demanding OS - complicated operation	- support of all available browsers - gigapixel support	- there is no free version - price 1799 € per month
3DVISTA	- 3D transition effects, - live panorama - animated panorama - inserting active points into the visualization	- paid version - complex operation	- multifunctional hotspots - creation of 3D objects - VR READY function - functionality in offline mode	- price € 299 per month - lengthy export

Based on the processed SWOT analysis, strengths and weaknesses comparison, and with regard to the opportunities and threats of the assessed virtual reality systems, one can conclude that although some of these systems are unique in their features, their operating costs are very expensive. On the other hand, systems that are free tend to have over-limited editing or sharing options. In some cases, the initial costs for accessing all functions of the particular system are very high, but ultimately, if maximizing use of the functions, the prices would be quite low. Another problem, in the case of many of the systems, is their considerable demand for computer hardware, which greatly prolongs the total processing time. Expedition creation, either through spherical photos or videos, is also dependent on the possibility of its sharing. All of these aspects have influenced the choice of the most suitable system, which was evaluated to be the virtual reality system ISTAGING. From our point of view, this system is the most suitable from all aspects to create an expedition through spherical photos. Among its greatest strengths are its intuitive control of the particular functions, trouble free functionality, and export during the material processing, as well as its acceptable demands on the technical equipment of the PC. Another selected platform to share the virtual reality expeditions is the YOUTUBE platform, which enables completely free sharing of the given content.

The results of the SWOT analysis of the selected camera systems (Table 2) from the point of view of their potential use in secondary vocational schools are summarized in Table 4.

Table 4. SWOT analysis of the selected camera systems. Source [81], own research.

Device	S—Strengths	W—Weaknesses	O—Opportunities	T—Threats
Insta360 One R	✓ high quality 4 K and 360° image in 5.7 K ✓ high quality recorded sound ✓ (two microphones) ✓ good quality display that allows a direct view ✓ compatibility holders	✗ small display	➢ easy-to-use controls for video/photo editing ➢ modular design (3 cameras in one) ➢ HDR Mode	⌧ susceptibility of lenses to damage
Insta360 One x	✓ many useful functions ✓ good image quality ✓ compatibility holders	✗ small display to display basic information about camera settings ✗ absence of waterproofing without accessories.	➢ easy-to-use control elements for video/photo editing ➢ HDR Mode	⌧ susceptibility of lenses to damage
GoPro MAX	✓ waterproof ✓ dynamic range ✓ manual control of exposition ✓ compatibility ofholders	✗ the video processing application had a negative impact on the performance of the computer. ✗ poor quality in low light	➢ stabilization	⌧ absence of slow motion 360 video
Ricoh Theta Z1	✓ good image in low light ✓ robust, easy-to-use design ✓ quality videos	✗ high price ✗ needs two applications for cutting	➢ easy handling	⌧ no micro SD
Theta SC	✓ shooting still images and 360 degrees ✓ affordability ✓ manual exposure control	✗ lower quality videos ✗ small internal memory ✗ poor battery life ✗ slow video transfer to phone	➢ affordability	⌧ problem with compatibility of the camera and the application from the manufacturer

As shown, considering the summary of the given SWOT analysis results processed for the commonly used five selected kinds of camera and their software accessories (Table 4), the system which best meets the particular stated criteria is INSTA360 One R. This means that this system is the most suitable to be used for the creation of didactic teaching aids, in our case, for the creation of virtual environments of school excursions. INSTA360 One R cameras offer video recording of the highest quality. Additionally, they enable connection to other external means supporting the quality of the processed picture and sound. A further advantage of these cameras is the freely accessible program INSTA360 Studio (in 2020 and 2021 versions), which is suitable for further adjustments and the export of video recordings.

6. Conclusions

New digital technologies support development in all areas of our lives, from production, through economy, to education and training, influencing their levels, efficiency, and achievements. Furthermore, in the area of education and training, they also have a significant impact on the design of educational policy, which is increasingly emphasizing the creation of educational environments to support the development of one's creativity [71,82–86]. E-learning, including virtual excursions, is an element that can serve as a platform to transfer education to new levels, from the point of view of both learners as well as educators [87–89].

Thanks to both virtual and augmented reality, teachers are no longer limited by the space of a classroom. Virtual reality enables virtual exploration of the entire world, while augmented reality enriches abstract concepts and enables teachers to guide their students through 360° scenes and 3D objects. Such systems can also introduce interesting locations and artefacts. If students are empowered to visualize information in a new way, their ability to store such information can be positively influenced. Based on the above presented analyses, our ambition is, with the help of the ISTAGING system, to introduce students to the premises of their possible vocational training to discover information about them, to view both their equipment and the working procedures carried out by them, and to directly monitor the functionality of the facilities and the production processes used in industry.

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