ZARZĄDZANIE MEDIAMI
Tom 10(4)2022, s. 265–279
doi: 10.4467/23540214ZM.22.018.17962
www.ejournals.eu/ZM

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THE POTENTIAL AND CONDITIONS OF THE DEVELOPMENT OF VIRTUAL REALITY IN EDUCATION AT THE HIGHER EDUCATION LEVEL*

Abstract

The paper explores the potential and determinants for the virtual reality usage in education at the higher education level. The article starts with the analysis of the evolving university's role. In this context, generational changes determining the VR usage in tertiary education are also discussed. Then the features of virtual reality and related terms are explained to make a basis for discussing VR as a learning aid of the 21st century. The paper closes with the case study analysis of immersive VR usage in higher education and further research recommendations.

Keywords: VR, XR, functions of the university, education, generational changes

JEL: I21, I23, I24, O32, O33

* The article was developed within the framework of the project "Experience and immersive technologies – from creative practice to educational theory" in partnership with Jagiellonian University, Łódź Film School, University of Malta and University of Athens (project ID number: 2020-1-PL01-KA226-HE-095891).

Introduction

There are many factors influencing the changes taking place in higher education. They include the changing vision of the role of universities, the implementation of private sector practices in the area of university management, the ongoing process of globalization, generational changes, and in recent years the COVID pandemic, which significantly accelerated the virtualization of many processes related to functions performed by universities. At the same time, it should be indicated that universities should, on the one hand, change under the influence of socio-economic processes and changes, and on the other hand, they should shape the desired changes in the environment.

In the era of globalization, educating and developing such competences that will allow an individual to understand multidimensional processes and predict their consequences, as well as make decisions taking into account their global context, is a challenge for education. As a consequence, this should translate into the use of development opportunities. This requires attaching great importance to education for peace and human rights, as well as development and environmental education (Czaplińska, 2010, pp. 491–496). New technologies also create an important context for the functioning of the university. It is also vital because university graduates should be prepared – in terms of knowledge and skills – for the challenges of the world, in which global civilization is transformed into a virtual civilization. The consequences of these civilizational processes affect the content of education, as well as the ways of teaching at universities (Targowski, 2023, pp. 530–582).

The purpose of the paper is to show the potential and determinants for the use of virtual reality in education at the higher education level. Achieving the objective of the paper required conducting a research procedure based on the review of the literature and case studies on the use of virtual reality in teaching conducted at universities. Special attention was focused on the evolution of the university's function and changes in the approach to teaching as well as generational changes as determinants for the use of virtual reality in university students' education. The features of virtual reality and their attractiveness from the educational perspective were also presented.

Methodological approach

Along with the evolution of the university's unique role in the society there is a need to consider how recent technological advancements shape the way teaching methods develop. The paper is framed within the sphere of analysing VR technology as an experiential learning tool in higher education environment. The framework

puts special emphasis on the VR usage as an innovation instrument at universities to show the potential of VR technology in this field. The following research procedures were adopted in this paper: 1) literature review uncovering the evolution of the university's function and generational changes as determinants for the use of virtual reality in university students' education, as well as the features of virtual reality and related terms, and 2) case study based on purposeful sampling (Patton, 2002). The case study application showcases the applicability of VR technology in the field of higher education based on two projects conducted at universities in Poland: "Experience and immersive technologies – from creative practice to educational theory" and The Centre for Simulation and Improvement of Security Management "Pro Patria, Pro Civium". The presentation of each case follows a repetitive structure. Firstly, the project design is illustrated, secondly, the innovative potential of the project is shown. A participatory research approach that allows the researchers to engage in explored educational settings was adopted. Additionally, the data was enriched by interviews with the project leaders.

Evolution of the functions of the university and changes in the approach to teaching as stimulants for the use of virtual reality in university students' education

The university, which originated as an institution in the Middle Ages, has evolved. This was accompanied by changes in the perception of its roles. The essence of the medieval university was the pursuit of truth and education, and Latin was the official lecturing language. Relations at the university had the form of a master-apprentice relationship at that time. The evolution of the roles performed by the university is related to the fact that scientific activity is gaining in importance. And so, for the Humboldt University, the unity of science and teaching is characteristic, and the idea is to employ the most outstanding scientists at the university as well as to guarantee them freedom in the field of scientific research. In turn, modern universities create, process, and disseminate knowledge in the environment, while internationalization – which concerns education, research and cooperation with the environment – is an important direction of their development (Leja, 2013, pp. 34–35, 185–187).

A modern university educates in the field of competences that have both basic and professional components, and thus combines in its mission general education with an education for the labor market. It should also be emphasized that the ability of graduates to find a job has become a key criterion for assessing the value of a university and the quality of its education. The development of various forms of cooperation between universities and the labor market is also observed (Budnikowski et al., 2012, pp. 4–17). For example, MIT has been employing

professors-practitioners for a long time, entrusting them with specialist classes (Etzkowitz, Dzisah, 2007).

From the point of view of the purpose of this paper, it is important to present the concept of the Third Generation University, which shows the directions of changes observed in the area of higher education and the evolution of the roles performed by universities. According to this concept, the role of universities is not limited to conducting research and education but is also expressed in taking care of the practical application of the created knowledge. The core activity of Third Generation Universities is conducting basic research as well as interdisciplinary or transdisciplinary research. In addition, the tasks performed by these universities include creating networks within which they cooperate with enterprises, private research and development institutes, financial institutions, professional service providers and other universities. This results, among others, in financing their activities both by the state and by the private sector. Universities of this type operate on the international market and compete for the best scientists, students and for research commissioned by representatives of economic practice. They create a special offer for students and the best employees with the greatest potential. In the management of the Third Generation University, great importance is attached to stimulating creativity in scientific work and having students and employees from various countries. They also act as creators of new entrepreneurship, because in addition to conducting research and teaching, their goal is also to ensure the use of know-how (Wissema, 2009, pp. 11–12).

Universities transform under the influence of profound changes taking place at the cultural, social and economic level. Demographic issues are a fundamental factor affecting the functioning of universities. This is accompanied by a change in the perception of the role of a student, who used to be a member of the academic community in the past, and now has become a key stakeholder and purchaser of educational services, often expecting specialized and practice-oriented education (Sułkowski, 2016, pp. 17–20).

This is inherently associated with the need to search for innovative ways of teaching which are attractive for students. They include those based on new technologies and solutions in the field of virtual reality.

Another premise for the use of virtual reality in teaching is the transition from classic forms of teaching to those strongly involving students. It is worth noting here that in the area of didactics there are many paradigms, which are often presented in polarized systems. They primarily distinguish the paradigm of knowledge-presenting teaching and knowledge-seeking, the paradigm of reproductive-transmissive and creative teaching, didactics of teaching and learning, technical-instrumental and humanistic didactics, or "final version" teaching and exploratory teaching (Rutkowiak, 2009, pp. 27–28).

These dichotomized divisions can, in general terms, be reduced to thinking about an individual in terms of a person being taught or a learning person. At the

same time, it should be emphasized that paradigms cannot only compete with each other, but often cooperate and complement each other. However, an increase in the importance of thinking about a student as a person learning, and not only a person taught is observed. This is another premise for the implementation of technology based on virtual reality in teaching.

Generational changes as a premise for the use of virtual reality in education

Striving to show the determinants of using virtual reality in the education of university students, the importance of generational changes should be mentioned. The concept according to which the generation of the post-war baby boom, generation X and generation Y and Z are distinguished is one of the well-known approaches to distinguishing generations in the literature on the subject. The distinguishing feature of people belonging to the post-war baby boom generation is the fact that this generation had its own authorities, and experts played a significant role among the influence factors. In addition, generational changes are associated with increasing individualism. What is more, such categories as focus on career, work in a corporate organisation, ambition, striving to achieve a high social status and, at the same time, a consumerist lifestyle are important in showing the values and behaviors characteristic of Generation X.

Generation Y, on the other hand, is distinguished by a wide range of Internet use and a positive attitude towards new technologies, which create, even though it may be relative, a sense of freedom and independence. This is accompanied by the disappearance of authorities. Often, the speed of decision-making, which is typical of this generation, displaces independent thinking. Generation Z, separated from generation Y, is characterized by an even greater range of using Internet in various spheres of life and the recognition of Internet communication as best suited to their needs. It is worth noting that opinions expressed by users of online communities play a significant role among the influence factors. At work, this generation strives to pursue their own passions and participate in interesting projects rather than stability. At the same time, it should be emphasized that for the representatives of this generation the participation in online communities is often an opportunity for expressing themselves and self-presentation (Aniszewska, 2015, pp. 2–7).

Generation Z is significantly diversified both economically and culturally, but its representatives are characterized by the pursuit of something more than meeting material needs. In motivating people belonging to Generation Z, it is relevant to refer to such values as new challenges or passion (Więcek-Janka, 2018, pp. 23–40).

For young people currently studying, it is not important what medium they use, as they very often easily use several of them at the same time. They are a generation

of viewers who are growing up immersed in multimedia culture. They rarely watch live TV, preferring programs that are pre-registered or downloaded from the Internet. The young generation, also referred to as the Internet Generation, is the antithesis of the TV Generation, i.e. the representatives of the post-war baby boom, and benefits from the effects of the shift from one-way media coverage to interactive media and participatory culture (Wątroba, 2022, pp. 71, 115). This is an important premise for the implementation of innovations in teaching, including those based on the potential of virtual reality.

Characteristics of virtual reality and their attractiveness from the perspective of education

Computer-assisted environments have become an important element in the way the humans perceive the reality. They generally refer to the use of computer technology to support and enhance various activities across many areas including education, gaming, entertainment, healthcare, and more. Virtual worlds cover "computer-assisted environments that attempt to recreate reality for the users using devices such as cameras, sensors, display, and projection devices" (Saxena, Verma, 2022, p. 3).

There are several terms covering the phenomenon of a simulated environment assisted by immersive technology (Kwok, Koh, 2021), e.g.: virtual reality (VR), augmented reality (AR), mixed reality (MR), and more recently, extended reality (XR) (Irvine, 2017). XR (*extended reality*) as an umbrella term includes VR, AR and MR technologies as well as any future technology. It "offers a unique sense of presence to the users by extending their reality in a way that computer-generated reality becomes indistinguishable from the actual physical reality" (Saxena, Verma, 2002, p. 7).

Virtual reality is defined in the context of a computer-generated three-dimensional environment that allows the user of this technology to interact with virtual artifacts (Guttentag, 2010, pp. 637–651). It is also referred to as a new interface paradigm that allows the user, thanks to the use of computers, to undertake various types of activities in a virtual environment (Bryson, 1996, pp. 62–71). According to this way of conceptualizing virtual reality, it is identified with the virtual environment (Berbeka, 2016, pp. 84–101).

VR (*virtual reality*) means a computer-generated simulation of real world by means of physical, tactile and visual dimensions (Rheingold, 1991). VR can incorporate non-immersive spaces (e.g. surrounding LCD panels stimulating some users' senses), semi-immersive spaces (e.g. flight simulator combining physical and virtual elements in a room) and fully immersive simulations sketching the physical world (Greengard, 2019). VR technology provides perceptual stimulation by using VR headsets or Google Cardboard.

Work on virtual reality technology was conducted as early as in the 1960s, when attempts were made to create systems capable of giving the impression of sensual presence in a space other than the one actually occupied. In the next stages, the development of design work related to virtual reality was aimed at creating such systems that would isolate the user from the real world and redirect their senses in such a way that they would only receive stimuli from the digital environment (Safjanowski, 2017, pp. 214–229; Górczyński, 2013, pp. 111–116).

Among the main differences between virtual and augmented reality, it should be emphasized that augmented reality complements and enriches the real world with virtual objects and does not prevent the user from receiving stimuli from the real world. Solutions based on augmented reality can allow for a better understanding of the real world and strengthening the real-time interaction of the user with it. They can also contribute to a fuller experience of the surrounding reality (Han, Leue, Jung, 2014; Ekonomou, Vosinakis, 2018, pp. 97–107). "While VR is a view of a world consisting only of virtual objects, which may be interactive, AR (augmented reality) is a view of the real world with superimposed virtual objects […] (text, images, or animation)" (Flotyński, 2020, vii). AR builds on physical reality and adds to it further features (Saxena, Verma, 2002). AR is widely used in the field of medicine (Eckert, Volmerg, Friedrich, 2019) by helping a surgeon to have a realistic perception of the operation procedure (Ha, Hong, 2016). Striving to show the phenomenon of augmented reality, it is worth referring to the concept of P. Milgram and F. Kishin which indicates the existence of the continuum of reality – virtuality and, consequently, the blurring of the boundaries between reality and virtuality.

The features of virtual reality that can be used to describe its essence, include, in particular, the following ones:

- simulation, representing the reproduction of the features of the real world and its individual elements in a digital environment or the creation of completely new, unique, computer-generated spaces reflecting the author's ideas;
- interactivity, responsible for enabling the user to transform and co-create the virtual environment with the use of a computer interface;
- artificiality, which is closely related to simulation and understood as a criterion differentiating virtual from physical reality;
- immersion, defined in the context of the illusion of being immersed in the virtual world and separated from the real world; it can occur both in physical and mental dimension;
- telepresence, defined as the ability to participate in events remotely thanks to the use of an intermediary system in the exchange of information with a remote environment;
- using hypertext network communication, which is the basis for creating virtual communities (Walczyk, 2019, pp. 133–141; Michael, 1993, pp. 112–114; Sherman, Craig, 2003, p. 9).

The multidimensionality of virtual reality is also affected by the fact that its features also include fictionalization, i.e. building a fictitious reality, as well as existence in its own time, which can flow in the same or different way than real time, because it can be stopped, slowed down, accelerated, and even undo (Bondecka-Krzykowska, 2016, pp. 202–212). It should also be emphasized that the experiences resulting from the use of virtual reality are greatly influenced by the imagination of its users (Burdea, Coiffet, 2003, p. 3).

Referring to the applications of virtual reality in the field of education, it should be noted that through new types of stimuli, virtual reality provides a different type of experience and sensation than those resulting from participation in traditional forms of education.

At the same time, it should be noted that virtual reality, which has great potential from an educational perspective, is not yet mainstream and is closer to the nineteenth-century experiments conducted by such film pioneers as the Lumière brothers than to *Citizen Kane*, an innovative film of 1941 directed by Orson Welles. Despite the existence of limitations, related to for example the need to use goggles, the time of using them, the development and spread of virtual reality leads to unprecedented impressions and highly engaging experiences (Bailenson, 2019, pp. 18–20, 222). The advantages of using virtual reality in the field of teaching are especially visible in the context of outlined changes in the approach to education and generational changes that take place.

Striving to achieve the goal of the paper and moving from general to specific considerations, virtual reality as a learning aid should be indicated, as well as the examples of the use of this technology in higher education should be presented.

VR as a learning aid of the 21st century

The breakthrough of modern VR technology came in the area of military training in the mid of 20th century. At this time Thomas A. Furness III was commissioned by the US Air Force to construct the first flight simulator in 1966 (Mertz, 2019). The term virtual reality itself was coined 20 years later by Jaron Lanier in the 1980s (Faisal, 2017).

Although VR technology is not new, the recent advancements including interactions and visualisations have strengthened the attractiveness of this technology among scholars, teachers, and educators. A high level of immersion involving a user in a virtual environment is made possible by means of modern VR head-mounted displays (HDMs), e.g. HTC Vive or Oculus Rift. This immersion is defined as "a perception of being physically present in a non-physical world by surrounding the user of the VR system created with images, sound, or other stimuli" so that a participant feels he or she is actually "there" (Freina, Ott, 2015, p. 133).

VR is also called a learning aid of the 21st century (Rogers, 2019). There are systematic literature studies analysing the VR in the field of education. In essence, they see VR as a promising learning tool in the context of higher education. Chavez and Bayona (2018) stress the key VR features that determine positive learning effects including interactive capability, immersion interfaces, animation routines, movement, and simulated virtual environments. Research by Krokos et al. (2019) shows that VR experience provides students with enhanced memory recall and it improves educational productivity. Suh and Prophet (2018) develop the stimulus – organism – response (SOR) framework for immersive technology use that is thought as a classification instrument. In this model, stimulus is a trigger intensifying immersive technology users' cognitive and affective reactions, organism relates to an internal evaluation by immersive technology users, and response covers an outcome of users' immersive technology use.

Radianti et al. (2020) explore the application of immersive VR in higher education. According to the scholars immersive VR technology is the most popular tool in the following domains: engineering, computer science, astronomy, but also medicine, earth science, biology and arts what draws a very diverse picture of the VR application across higher education. The purpose of VR use in education might cover the following situations (Kavanagh et al., 2017):

- simulation seen as participating in lifelike virtual exploration (Gaitatzes et al., 2002) demonstrate an example of VRs ability to virtually explore locations of Greek cultural heritage what would otherwise be infeasible in a classroom);
- training facilitating the transfer of practical skills (e.g. flight simulation in pilot training, medical activities in surgical education);
- access limited resources used to simulate the access of limited resources (e.g. Abichandani et al. [2014] describe a virtual wind farm supporting wind energy education where students can modify the wind farm parameters to experience data changes);
- distance learning – it is a key factor assuring that students using VR technology at distance learning have comparable learning experiences to those provided in a classroom (e.g. Schwaab et al. [2011] created a virtual examination room for emergency medicine students that was accessible through the Second Life software. Students would there play the role of the doctor, and the supervisor would control the patient avatar).

VR in higher education is commonly used to teach (Radianti et al., 2020):

- procedural-practical knowledge (e.g. filing a report);
- declarative knowledge (e.g. learning planet names) or theoretical concepts;
- analytical and problem-solving skills (e.g. diagnosing patients);
- other skills including communication, collaboration, soft skills, behavioral impact, and learning a language.

The authors stress that VR applications lack in-depth reference to existing learning theories. The most commonly mentioned one is the experiential learning

theory by Kolb (1984) where students immerse in an experience to explore a given environment (Chen et al., 2005).

Immersive VR usage in higher education. The case studies

Case study 1. "Experience and immersive technologies – from creative practice to educational theory"

Project design

The project "Experience and immersive technologies – from creative practice to educational theory" is conducted by the Jagiellonian University in cooperation with The University of Malta, The Łódź Film School and The National and Kapodistrian University of Athens in the period May 2021 – April 2023.

The project responds to the need to enrich the existing educational university programs for both cultural and media managers, but also for artists. The project's objective is to develop an educational offer for these groups in the field of immersive media at the higher education level (new curricula, syllabi for immersive technology courses). More specifically, the project aims at increasing the skills and competences of the participants in designing and evaluating immersive experiences to manage culture in the digital field (by means of specialized training courses both for students as well as for teachers). The focus of the project is also on the elaboration of open educational resources in the field of experience management and culture with the use of immersive technologies.

The innovative potential of the project

The project helps building an open attitude of students and academics towards the application of new technologies in the humanities. The underlying analysis tool, the so-called "research as a practice" (Barret et al., 2007) allows to gain new knowledge required to revise an educational program and develop an enhanced curriculum. The acquisition of essential skills both by students in culture and media management (prospective managers), as well as artists and academic teachers becomes an urgent call for many reasons. Among them are: to provide future audiences with a new quality of cultural participation, significantly improve educational results, and develop further levels of study.

The project innovativeness lies in the following aspects:

- methods of work: process of generating knowledge and transferring it from artistic practice to university courses. It heavily stresses the role of introductory experience of participation that forms the basis for developing practically-oriented university curricula;
- subject: its result is the improvement of the quality of educating cultural and media managers and artists at the university level. It is an indirect step towards strengthening cultural markets, and stimulating the ongoing innovation in the cultural field.

Case study 2. The Centre for Simulation and Improvement of Security Management "Pro Patria, Pro Civium"

Project design

The Centre for Simulation and Improvement of Security Management "Pro Patria, Pro Civium" was established at the Pedagogical University in Kraków (Centrum Symulacji i Doskonalenia Zarządzania Bezpieczeństwem, www.up.krakow.pl/uniwersytet/jednostki-ogolnouczelniane/4092-centrum-symulacji-i-doskonalenia-zarzadzania-bezpieczenstwem-pro-patria-pro-civium). The Centre plays the role of a simulation centre to strengthen the educational and research capacity in the field of health security, social security, national security and crisis management. The Centre conducts, among others, VR training in first aid and active shooting scenarios for students in national security as well as for other stakeholders. Other projects are related to the implementation of preventive, diagnostic and educational programs in the area of security as well as development of practical competences for the students in security studies.

The innovative potential of the project

The Centre noticed the lack of training opportunities in a university environment to react an active shooting attack. The Centre responded to this problem by developing an immersive VR simulation game for counterterrorism and active shooting scenarios preparedness. The game enables single-based training for students. The game's concept is based on experiential learning fulfilling the following learning stages: experiencing, reflecting, abstracting, and acting (Fromm et al., 2021). The scenario applied in the simulation is relatively simple and short to concentrate on the effectiveness of players' decisions. The simulation provides a life-like scenario without any actual hazard. The students can engage in tasks, make decisions, and observe consequences what is very beneficial from the pedagogical perspective. Finally, they can analyse all decisions taken while playing. In this regard, the game

provides a player with interaction, immersion, and authenticity in a learning environment.

The innovative element of the project is the use of a realistic scenario for training students in the event of a terrorist attack and a hostage situation. With a relatively small financial investment related to the purchase of equipment (head-mounted displays) and the game development, students have the opportunity to train practical skills in game-based learning. Scenario-based learning is emphasised as a valuable tool for providing education into practical "real-world" skills (Kavanagh et al., 2017). Therefore, VR technology creates new opportunities in the field of practical hands-on education.

Conclusions and summary

This paper presents the potential of introducing VR technology at the higher education level and this issue will confront us in the field of university teaching in the near future. Among the consequences for the education process resulting from the virtualization of social life, it is necessary to primarily indicate the need to develop such an education model in which the use of new technologies, including virtual reality, will contribute to the fact that university graduates will have high competences in obtaining information, communicating, lifelong learning and creating innovative solutions in many areas of socio-economic life (Abramowicz, 2005, p. 11). The virtualization of didactics should be focused on creative teaching that promotes knowledge creation and sharing.

VR technology has the potential to revolutionize many areas, including education. In this sphere VR can be used to create immersive learning experiences that allow students to interact with digital content in a more interactive way. VR offers engaging education supporting experiential learning since the students are able to experience learning by doing. An important advantage of VR usage in the educational environment is the ability to create more memorable experiences that enhance productivity of a student through better recall of large amounts of information. Improved learning outcomes are not the only positive effect of VR-supported-learning. Among other benefits are increased learning motivation, higher level of learning interest, also the possibility of enabling learning through "live experience".

Future research could focus more specifically on the evaluation of the possibilities and constraints of VR for experiential learning in higher education. Though there are many scenarios of VR applications, the development of VR usage schemes in higher education curricula would give deeper insights into the practical implementation of VR technology.

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