Teaching with XR (Extended Reality) in Higher Education:
An Analysis of Student perceptions

Ahmet Ustun

&

Siba El Dallal

Abstract

With the increasing rate of shifting the educational methods to the online format, immersive technologies such as XR (Extended Reality) can help create a unique active learning experience in the new online/hybrid format and take it to the next level. This qualitative study explores the potentials of XR— particularly the Virtual Reality (VR) technology in higher education to enrich student's experiences. The perspectives of students at a public university were collected during the Spring 2019-2020 semester. The findings suggest that VR technology provides positive opportunities to enhance student learning experiences, including, but not limited to, promoting creative thinking, offering effective learning, encouraging learning by doing, creating motivating, entertaining, and intriguing learning environments, in spite of its high costs, potentials physical hazards and accessibility challenges. Recommendations for effective implementation were identified. Directions for future research on XR in online and hybrid learning were also discussed.

Keywords

Introduction

The use of immersive extended reality (XR) is proven to be an effective way to augment traditional forms of pedagogy (Brown et al., 2020). XR education evolves widely in higher education in the past few years as a field that provides unique hands-on experiential learning and helps motivate students to achieve the desired skills and knowledge. Research studies revealed a link between the usage of XR technologies and improvements in students' academic performance and motivation, students' social and collaborative skills, in addition to students' psychomotor and cognitive skills. With the transition to an online format, XR technologies can help bridge the gap between the in-person and online courses and create a space for more collaboration and presence opportunities. However, empirical research on its applications in higher education is still inadequate (Radianti, Majchrzak, Fromm & Wohlgenannt, 2020).

With the recent development, the ease of use, the proven dramatic impact on pedagogy and the noticeably decreased cost of the XR equipment, implementing XR technologies as learning tools becomes one of the most active fields of innovation and research among the various higher education institutions (Pomerantz, 2019). XR technologies offer learners a unique learning experience that may be unattainable in a traditional educational format. This paper

reveals the perspectives of students, who were pre-service teachers at the Faculty of Education at a public university, of their VR experience in the several courses they studied during the spring semester of the 2019-2020 academic year to develop a deep understanding of the usage of VR in higher education within its various modalities. The findings discuss the effectiveness of VR technologies in creating unique learning experiences to meet the learning goals and how these technologies can help achieve them to enhance student learning and engagement.

Methodology

Research Design

A qualitative research method was employed to examine the opinions of pre-service teachers of utilizing virtual reality (VR) applications for educational purposes at a public university. The aim of using a qualitative research method was to obtain a deep understanding of the participants' perspectives about using virtual reality in educational environments. Yıldırım and Şimşek (2008) indicate that this method allows researchers to gain in-depth information about the subject holistically.

Participants

The research participants were 17 university students who took an elective course during the spring semester of the 2019-2020 academic year. Participants were sophomores at the Faculty of Education in a public university, studying different academic programs, including Mathematics, Turkish Language, Counseling and Guidance, and Psychological Counseling.

Data Collection

A semi-structured interview form was developed and employed by researchers to determine the opinions of preservice participants in utilizing VR applications in higher education. Experts in the learning Design and Technology field assessed the interview questions, and based on their revision and suggestions, the interview questions were modified and finalized.

Data Analysis

Thematic analysis method (Hsieh & Shannon, 2005) was used to analyze the collected data. Data from in-depth semi-structured interviews was analyzed after transcription through manual coding using the inductive approach.

In order to interpret the participants' perspectives in an understandable manner, specific themes were developed by grouping the codes and then interrelating them to establish categories. Meaningful integrations are made in the analysis to describe the findings (Yıldırım ve Şimşek, 2013). For the coding process, thematic coding was used to identify the main themes emerging across the 17 interviews. Codes were grouped under themes and sub-themes and interrelated to develop the findings categories. The validity of the qualitative results was constructed by applying three validation strategies (Creswell and Clark, 2017), including member checking, triangulation of the data from several resources, and asking other researchers to examine the data and review the results. To check the coding reliability, the formula (number of codes agreed by

researchers / total number of codes) by Miles and Huberman (1994) was used. The reliability percentage of the coding between coders was determined as %89.

Findings

Pre-service teachers' opinions about the use of virtual reality were analyzed through thematic coding in accordance with the aim of the research. The themes and sub-themes that emerged as a result of examining their opinions of using virtual reality applications for educational purposes were identified. The findings from this study were organized into four themes: usability, benefits, uniqueness, and drawbacks, as presented in Table 1

Table 1. Students' Views of Virtual Reality Experiences

Themes	**Sub-Themes**	**Number of Students**	***Examples of Participants' Opinion***
Usability	Easiness	1	P-6 "Experiencing VR is easy to use and entertaining. I did not encounter any negative aspects of using VR".
	Difficulty	4	P-10 "Those who will use VR applications should have knowledge about the use of technological equipment". P-11 "The downside is that VR is difficult to use; sophisticated equipment is needed to use it".
Benefits	Creative Thinking	4	P-8 "The use of VR can inspire creative learning". P-11 "VR inspires creative learning. It provides opportunities for the development of new understandings and perspectives… It offers different perspectives and creativity".
	Effective Learning	5	P-1 "VR increases the retention of learned information". P-3 "VR offers better learning opportunities for students by creating visual memories".
	Abstract to Concrete	8	P-5 "A student cannot fully visualize the shape of geometric objects in his mind so he can often give incorrect answers in response to questions related to 3D objects. However, this problem can be solved with VR applications". P-16 "VR can make the abstract concepts tangible, which cannot be done with other technological tools".
	Motivation	6	P-12 "VR can play a more instructive, attractive and encouraging role for students in their learning". P-16 "I can use VR to motivate students who are preparing for the national exam".

	Active Learning	4	P-9 "VR encourages passive students to actively participate". P-13 "VR provides experiences of learning by doing, which promotes the retention of learned knowledge".
	Reinforcement	1	P-9 "VR can be used in areas where students have a lot of misconceptions about a subject to correct them or it can be used in lessons in order to reinforce the topics they learned".
	Entertainment	7	P-2 "More enjoyable learning can be achieved with 3D animations". P-11 "Interesting and entertaining games can be created with VR for solving mathematical problems such as four operations".
	Intriguing	7	P-10 "VR can be used to attract attention in the introduction part of the lesson and provide detailed information in the development part". P-14 "I can use VR because its applications are attractive".
Uniqueness		14	P-4 "By implementing VR, I can take a student to a more comfortable environment which can be supportive of the treatment process instead of taking the student to a usual guidance service room". P-7 "It is possible to have students enter a virtual room with geometric objects". P-8 "We can watch famous painters who lived in the past while drawing in their painting room as if they are still alive".
Drawbacks	Cost	11	p-13 "Various necessary technologies such as processor, sufficient memory and graphics are highly expensive for VR". P-15 "There are a lot of advantages, but the VR headsets are expensive to purchase, which seems to be a disadvantage".
	Conditions	5	P-2 "VR technology can be affected by environmental conditions very quickly, thus affecting its efficient operation". P-13 "There are certain conditions such as having suitable light and quiet environments to experience".
	Accessibility	6	p-9 "VR devices cannot be accessible to everyone". P-12 "In the current economic situation, VR usage causes the inequality of opportunity because of the difficult accessibility of VR".

Physical hazard	4	P-8 "VR may have harmful effects on our eyes such as visual impairment, strabismus and so on". P-11 "You may drop and hurt yourself while experiencing VR on your own".

Table 1 showed 14 sub-themes under the four main themes— usability, benefits, uniqueness, and drawbacks.

Usability This theme refers to pre-service teachers' thoughts if they were able to use VR applications easily. Although one student emphasized the ease of using VR applications, 20% of the students (n=4) indicated that integrating VR in education was difficult and required lots of technical support and knowledge.

Benefits: This theme refers to the advantages that VR offers when it is utilized for educational purposes, and it's classified into eight sub-themes consisting of creative thinking (23%), effective learning (23%), abstract to concrete (47%), motivation (35%), active learning (23%), reinforcement (6%), entertainment (41%), intriguing (41%). **Creative thinking** refers to students' ability that is promoted by the VR technologies to find a solution in an original way. 23% (n=4) of the participants identify creative thinking as one of the main benefits of adopting this technology in education. VR presents students with personalized, hands-on learning activities and plays an important role in helping students to think critically. The collaboration and immediate feedback can help students to improve their critical thinking and their learning outcomes. 23% (n=4) of the participants also believed that VR has the potential to encourage **effective learning**, which refers to accommodation and assimilation of new knowledge and ideas permanently and concretely. Moreover, about 50% (n=8) of the participants believed that VR helps students enhance a tangible understanding of **abstract concepts**, which we refer to by Abstract to concrete. The terms **motivation** refers to the use of VR to motivate students to learn enthusiastically; 36% (n=6) of the interviewees identified this benefit. **Active learning** refers to student engagement in the learning process in an active manner by VR; 23% of participants found active learning important, whereas only 6% of the participants (n=1) only identified the **reinforcement**. Reinforcement refers to the VR effects to strengthen student learning or to make their misconceptions corrected. Both **Entertainment & Intriguing** were identified as the most important benefits of VR. Entertainment refers to the VR effects in making the learning fun. Whereas, Intriguing refers to the fact that VR induces students to know more. 80% (14 out of 17) of the participants claimed that VR offers a unique learning experience.

Uniqueness: It refers to the unordinary learning opportunities that VR provides students with. VR can offer an authentic, exhilarating, and lifelike learning experience.

Drawbacks: This theme refers to the disadvantages that students might encounter when utilizing VR in the educational process. Four sub-themes emerged under this category, including the high cost of VR technologies, accessibility, physical hazards, in addition to the environmental context.

More than 60% of the participants found the high cost of the VR technologies, including the cost of its headsets, powerful computer peripherals, and the VR applications, was one of the biggest challenges that encounter the higher education institutions. The cost refers to the amount

students have to pay to obtain a VR headset and buy its software. 30% of participants identified providing the environmental conditions is important to create an effective learning experience. Conditions refer to the inside or outside environmental context. VR can be utilized best when certain inside or outside environmental conditions occur. 35 % of the participants identified accessibility as a challenge for implementing this technology in education. Accessibility refers to VR access challenges in which access to this technology cannot widely be acquired because of its availability and cost. And a little more than 20% of participants found the Physical hazards resulted from the implementation of this technology help prevent this technology spread. Physical hazards refer to the possibility that students might accidentally hurt themselves because they cannot be aware of their surroundings while using VR technologies.

Discussion

This research was carried out to reveal the opinions of students who were pre-service teachers about utilizing VR applications for educational purposes at a public university. Based on the data analysis, VR has its unique benefits as well as drawbacks when used in educational settings. According to their perspectives, the use of VR applications provides opportunities for students to learn by doing. It creates an effective virtual learning environment where students are engaged in learning activities that are interesting, entertaining, and informative. This kind of learning environment motivates students to become active knowledge seekers. Besides, students easily comprehend abstract concepts in these virtual learning environments where abstract concepts become concrete objects. It can be stated that the use of VR offers instructive, attractive, and encouraging learning experiences for students. In parallel with these findings, Hussein, and Natterdal (2015) identified the benefits of VR in geology, medical studies, history, engineering, and so on. They showed that VR offers interactive learning environments in which students are active in their learning, such as performing an experiment in a virtual science lab or exploring the ancient world by traveling to places. Also, they indicated that students are encouraged to be creative in virtual learning environments where they can find opportunities to demonstrate their creative abilities in architecture and other fields. Furthermore, Kamińska et al. (2019) identified several advantages of using VR in educational settings, including increasing student engagement, providing interactive and attractive learning opportunities, maximizing the effectiveness of the learning environment, and encouraging students to be active in their learning. A study conducted by Makransky and Lilleholt (2018) revealed that the use of VR makes the learning environment enjoyable, engaging, and motivating with great features of VR. Ustun, Yilmaz, and Karaoglan Yilmaz (2020) found that students' performance and motivation can be maximized by utilizing VR applications. Besides, pre-service students also indicated that VR offers unique learning experiences. Providing unique learning experiences can be considered as a significant advantage of VR (Kamińska et al., 2019). Pre-service students emphasized the ability of VR as an educational tool that provides a 3D virtual learning environment. It cannot be possible to create such a virtual environment and promote learning without VR technology. They indicated that students could go to historical places regardless of their locations, meet famous scientists, artists, and any person who left a mark in history, and experience anything that we can't partake in the real world.

On the other hand, the study findings identified the disadvantages of VR. The main disadvantage was its cost. Pantelidis (2010) highlighted the high costs of VR as a primary drawback. The VR high cost is one of the main factors that prevent utilizing VR as an educational tool. The findings

also indicated that the accessibility of VR technology might cause inequalities in technology usage because many students cannot obtain these technologies. The use of technology in education is supposed to promote educational equity (Warschauer & Matuchniak, 2010); however, VR usage deepens the educational inequity in the society, especially in underdeveloped countries. Moreover, studies revealed that the extensive usage of VR might have harmful effects on human health such eye disorders, including visual impairment or strabismus, in addition to the potential dizziness and nausea after using the headsets.

Conclusion

Extended reality (XR) immersive technologies have massive potentials to enrich teaching and learning in Higher education through their abilities to offer a unique hands-on experience that might be unattainable previously with other educational technologies. The latest generation of XR technologies such as Oculus Quest 2 showed great improvement and enhanced performance; they are relatively affordable, wireless, less nauseating, and provide a safer experience.

References

Brown, M., McCormack, M., Reeves, J., Brooks, C., & Grajek, S. (2020). EDUCAUSE Horizon Report. *Teaching and Learning Edition. Louisville, CO: EDUCAUSE.*

Hsieh, H.-F., & Shannon, S. E. (2005). Three Approaches to Qualitative Content Analysis. *Qualitative Health Research*, *15*(9), 1277-1288. https://doi.org/10.1177/1049732305276687

Yıldırım, A. & Şimşek. H. (2013). Sosyal Bilimlerde Nitel Araştırma Yöntemleri. [Qualitative research methods in the social sciences.] Seçkin Yayıncılık. Ankara.

Miles, M. B., & Huberman, A. M. (1994). Qualitative data analysis: An expanded sourcebook (2nd ed.). California: SAGE Publications

Tunur, T., Hauze, S. W., Stuhr, P. T., & Frazee, J. P. (2020). *The Impact of XR-Immersive Labs on Student Motivation to Learn Kinesiology* (No. 3233). EasyChair.

Pomerantz, J. (2019). Teaching and Learning with Extended Reality Technology. *Information and technology transforming lives: connection, interaction, innovation.*

Martín-Gutiérrez, J., Mora, C. E., Añorbe-Díaz, B., & González-Marrero, A. (2017). Virtual technologies trends in education. *EURASIA Journal of Mathematics, Science and Technology Education*, *13*(2), 469-486.

Radianti, J., Majchrzak, T. A., Fromm, J., & Wohlgenannt, I. (2020). A systematic review of immersive virtual reality applications for higher education: Design elements, lessons learned, and research agenda. *Computers & Education*, *147*, 103778.

Parsons, T. D., & Trost, Z. (2014). Virtual reality graded exposure therapy as treatment for pain-related fear and disability in chronic pain. In Virtual, augmented reality and serious games for healthcare 1 (pp. 523-546). Springer, Berlin, Heidelberg.

Warschauer, M., & Matuchniak, T. (2010). New technology and digital worlds: Analyzing evidence of equity in access, use, and outcomes. *Review of research in education*, *34*(1), 179-225.

Pantelidis, V. S. (2010). Reasons to use virtual reality in education and training courses and a model to determine when to use virtual reality. *Themes in Science and Technology Education*, *2*(1-2), 59-70.

Hussein, M., & Natterdal, C. (2015). The benefits of virtual reality in education: A comparison study. (Bachelor thesis). Chlamers University of Technology, University of Gothenburg, Göteborg, Sweden. Retrieved from http://hdl.handle.net/2077/39977

Kamińska, D., Sapiński, T., Wiak, S., Tikk, T., Haamer, R. E., Avots, E., Helmi A., Ozcinar C., & Anbarjafari, G. (2019). Virtual reality and its applications in education: Survey. Information, 10(10), 318.
Makransky, G., & Lilleholt, L. (2018). A structural equation modeling investigation of the emotional value of immersive virtual reality in education. Educational Technology Research and Development, 66(5), 1141-1164.

Ustun, A.B., Yılmaz, R., Karaoğlan Yılmaz, F. G. 2020. Sayfa 56. "Virtual reality in medical education". In Sajid U. (Ed.), Mobile Devices and Smart Gadgets in Medical Sciences, IGI Global. DOI:10.4018/978-1-7998-2521-0.

Authors

Ahmet Berk Ustun (Ph.D.) is currently an associate Professor at Bartin University, Turkey. He earned his PhD in Learning Design and Technology from Wayne State University, Detroit, Michigan. He received his master's degree in Computer Education and Instructional Technology from Gazi University, Turkey and his bachelor's degree in Computer Education and Instructional Technology from Selcuk University, Turkey. His research interests are in online and blended learning, mobile learning, emerging technologies and MOOCs.

Email: ustun.ab@gmail.com

Siba El Dallal (**Ph.D**.) is currently a Learning and Teaching Technology consultant at the College of Literature, Science and the Arts (LSA)- University of Michigan- Ann Arbor, where she partners with LSA faculty utilizing technology to enhance teaching and learning processes. She is a Ph.D. graduate in Learning Design and Technology program at Wayne State University. She earned two master's degrees in Learning Design and Technology from Wayne State University and Interdisciplinary Studies and leadership from Buffalo State University- SUNY-NY. Prior to U-M, she was a graduate research assistant and an adjunct faculty at Wayne State University. She is extremely interested in emerging technologies in Education. Her research work is focused on technological change management, LMS and the effective implementation of emerging technologies in education.
College of Literature, Science, and the Arts | University of Michigan
2014 Modern Languages Building | 812 E. Washington Street | Ann Arbor, MI 48109
Email: sibael@umich.edu