The Current Perceptions About Instructional Tools in Educational Towards Adoption of Virtual Reality Among Undergraduate Students

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Abstract—Virtual reality (VR) has emerged as a major tool in this field of research and education development. However, many challenges arise for students during the course of instruction and learning. The learning process, the placement of support assessment variables, and the behavioral intention to continue using it within the learning spectrum are crucial to the success of virtual reality in the educational sector. The goals of this study are to inquire into the degree to which VR is now being utilized in the field of education. In addition, Thematic analysis was used to analyze the data since it provided an applicable approach to use across the interviews, many methods combined into this study. The study polled 32 teachers and analyzed the results with advanced analysist tools. All of the proposed points were determined using the data analysis. The finding of this paper that the initial round of interviews questions were aimed to discover more about the participants' backgrounds, including work titles and gender. The current study was intending to ability to use VR as an instructional tool was discovered as shown in the results of the survey interview in this paper.

Keyword—technology learning, virtual reality System, thematic analysis

1 Introduction

Modern technology appears to be an effective method of teaching students. Computer technology has made them more common in teaching during the previous few decades. They have clearly become increasingly essential in recent years, not only as an effective and efficient supplement to traditional methods of education, but also as the primary source of knowledge and the development of professional abilities [1] [2] [3]. However, the SARS-CoV-2 virus epidemic prompted a rapid shift, with many universities increasingly relying on apps and information systems to teach. People didn't see each other as frequently during a pandemic, which meant they couldn't go to physical facilities, equipment, and other necessities. Such an occurrence made it difficult, and for a time, it even halted some forms of trips, internships, and real-world training. Considering globalization, we must be mindful that such events may occur again, and

we must devise new methods of teaching that make use of modern teaching instruments. When it comes to this issue, virtual reality technology is one of the most effective solutions [4] [5] [6]. the behavioral intention to continue using it within the scope of learning, the development of support evaluation variables, and the learning process are among the most important key factors affecting the process of education and the continuity of education, and it is essential for the success of virtual reality in the educational sector, which enhances the instillation of a true sense of the student [7] [8] [9] [10].

As technology advances, an educator may be curious in how technology may be integrated into the core of learning. They may also pay attention to future innovations that may provide them with a diverse set of teaching strategies to employ in the classroom. This phenomenon has resulted in a new method of teaching that is extremely different from how people have been learning for the last decade [11]. This new strategy is based on commonplace technologies such as the Internet and mobile phones. To stay up with this quick rate of change, educational researchers must continue to investigate how these changes may affect their classrooms and how learning in general may change [2] [12] [9] [13] [14] [15].

Educators and researchers have both contributed to a better knowledge of how to best integrate real-world activities into online learning. VR technology have advanced significantly, allowing learners to interact with virtual environments. According to this study, using VR may assist students enhance their academic standards and performance. In the classroom, students should be taught how to use new VR technologies ([16]. Advanced virtual reality learning environments could be built to bridge the theoretical learning in traditional classrooms with the real-world application of knowledge in virtual reality environments. Virtual reality, along with the Internet and other modern communication, visualisation, and simulation technologies, is a significant technical tool for building learning environments that provide students with a more authentic learning experience [17].

The existing literature on the use of virtual and augment reality in education is summarized in the learning efficacy of online virtual platforms and the factors influencing student virtual learning experiences [42][43]. According to [18], perceived usefulness and playfulness were significant factors in predicting students' attitudes and behaviour intentions to use these technologies for learning, although ease-of-use was not. [19] researched computer-supported collaborative classrooms based on the UTAUT2 model and discovered that all examined parameters influence student acceptance and utilisation. Performance expectancy, effort expectancy, social influence, facilitating situations, hedonic motivation, price value, trust, self-efficacy, and personal innovativeness are among the factors studied. Overall, the studies reviewed above aided in a better understanding of the challenges surrounding the usage of virtual reality technologies in education. One could claim that a body of knowledge has been accumulated in this field. However, there are flaws in the present under-researched literature that demand further investigation in this topic.

The research questions that guide this study is as follow:

What are the Omani universities' current perceptions about instructional tools in educational settings towards the adoption of virtual reality among undergraduate students?

The goal of this research is to determine learners' understanding of VR as a learning medium and to research on the implementation of VR in the educational institution. The research draws on previous studies by filling the void by observing the understanding of student acceptance of technology. The objective which are aimed to be achieved in this study is as follows:

To identify the Omani universities' current perceptions about instructional tools in educational settings towards adoption of virtual reality among undergraduate students.

This paper is divided into multiple sections; starting from the literature review which contain the historical development of virtual reality, then the role of virtual reality in education, Teaching and learning with VR. next are the interview data analysis, the themes based on the interviews information, lastly ended with a discussion and conclusion.

2 Literature review

The term "virtual reality" has no precise meaning. Individuals have the same meanings, but the specific meaning of VR appears to vary based on the context. Its description and context have likewise changed dramatically in recent decades. The term "virtual" has also been used in the context of computers to indicate something fictitious that is generated by mechanical equipment. VR was used to define hardware such as standalone simulators, CAVEs, and head-mounted displays (HMDs) [20]Virtual reality has also been used to describe advancements such as computer-generated virtual environments and large multi-layered role-playing games. For example, [21]illustrated the need of distinguishing between simulated 2D screen interactions and perceptions using real 3D VR, such as HMDs [21] [22] [23] [24] [25].

[26] defined virtual reality as a computer-generated cosmos that can be seen as physical. This is comparable to how many people define virtual reality now [26]. [27], on the other hand, described VR as "creating targeted behaviour in an organism through artificial sensory input when the organism has little to no experience with interference." This description includes several of the most important characteristics of VR and does not limit the concept to any specific hardware or software. This demonstrates that virtual reality is more than just a computer-based experience; it can also be utilised as a target vision [27].

Although the phrase "virtual reality" is imprecise, certain VR-related terminology is designed to limit its definition. There have been various previous names for VR over the years before it was eventually created to be what it is now. For example, the term "virtual worlds" predates the term "VR," although they are now routinely used interchangeably [27].In terms of interpretation, the words "virtual" and "realities" are also somewhat contradictory [26]. Alternative words such as "vitality" exist but are rarely used. As a result, the preferred term will be abbreviated as "VR" in this work.

"Increased reality" often refers to viewing the physical environment via a glass or camera, with virtual objects or graphics affecting the observed surroundings. In this context, the term "VR" often refers to totally synthetic environments, but it is not confined to computer-generated visuals. The term "mixed reality" refers to the combination

of virtual reality, augmented reality, and everyday reality. With advances in unifying technology, these boundaries are no longer as clear, and a new term known as "X reality" has been developed to encapsulate all aspects of VR [27].

It's difficult to determine when VR was originally conceived, therefore it depends on the environment. Stereoscopes, for example, were invented in the 1800s and used to make a pair of images appear three-dimensional. View-Master further optimised the lightweight form of this technology, which resembled what is now known as Google Cardboard. This was not the case with VR; it was simply the beginning of 3D images.

The Haunted Swing, which was created in the 1800s, was a mechanical illusion that may be described as a type of VR experience. A group of individuals may be continuously spinning on the Ghost Coaster, but the atmosphere around them may be completely reversed, giving the impression that the ride itself is moving quickly for the participants. This has produced very close to motion-like effects to what the current VR systems have produced today, and the setup is technically a 360-degree VR experience.

As time progressed, technological improvements in the 1900s brought along new innovations, some of which were similar to present VR equipment. Not only in this period, but science fiction has also begun to incorporate the concept of parallel life and to question the essence of reality. Pygmalion's Spectacles may have been the first science fiction tale to depict a human seeing another realm through spectacles [26]. This is the closest thing to what contemporary augmented reality headsets strive to and can do. During this time, the first flight simulators were also produced, with the military being the target consumers. These simulators were, of course, unusual at first, but they were swiftly adopted by the military throughout WWII [26].

The Sensorama, created by Morton Heilig in the mid-1900s, was a fantastic film experience. It was a stationary platform featuring a lot of interesting features, including a broad colour field vision, stereo audio, motion benches, fans, and even smell sensors (Jerald, 2018). Ivan Sutherland later created the Damocles Blade, the first genuine head-mounted monitor with head-tracking and computer-generated visuals [26].

With the first incredibly cheap and effective HMDs at the end of the 1900s, augmented reality finally boomed as its own company. Jaron Lanier has also used the term "virtual reality" correctly in this occasion. Modern virtual interfaces and applications for leisure and research have also been created, and well-known firms have invested in virtual reality (Jerald, 2018). Since the end of the 1990s, VR has made a variety of promises, and hopes have been high—it was evident that technology had not yet been able to deliver [26].

Moving on to the present, VR was rather "silent" in the early 2000s. Of course, a variety of fields have been developed, but no considerably new or innovative discoveries have been discovered. However, in the 2010s, VR began to rebalance and boom once more. Until now, VR has only been available in limited situations, such as combat simulations or medical schools. Oculus released the first consumer-friendly VR HMDs in 2013, followed by its own versions. This was great news for the area of virtual reality, since its low price made it more affordable to users, and its promise to the gaming industry encouraged many major firms to invest in VR. Along with price, another major aspect of the most recent HMDs was a much larger FOV (Field of View), which has a profound influence on user interface and immersion [20].

The state of VR is now more understandable as a result of this brief history of its evolution. Technology has advanced sufficiently to allow augmented reality to be used in mainstream education rather than just specialized high-level training. Although it has been established that VR is more than simply HMDs and the like, the concept of VR used in this research is computer-generated environments that replicate the actual world. Because education is an important component of this research, the primary focus will be on newer, more user-friendly, and simple-to-use VR technologies, particularly different HMDs.

People have benefited from the advantages of VR's other appealing features. Previously, VR was thought to be quite effective in teaching, with simulators becoming one of the first VR deployments. HMDs and other VR devices can be utilized as standardized educational mediums, where they may offer some additional benefits and may even outperform traditional pedagogical mediums in some situations [28].

There are numerous benefits to adopting VR in training. VR has been shown to be beneficial in military and surgical training over long periods of time. Nonetheless, it was critical in this analysis to focus on the changes that would be realized as a result of the implementation of VR in educational settings. examined a number of articles on the use of HMDs in the classroom. VR benefits can be divided into three categories: perceptual, psychomotor, and emotional ability development [20]. These are general-purpose benefits, but they are equally valuable to all students.

Cognitive talents are particularly significant in educational settings since a wide range of studies are conducted to foster and sharpen such skills. The usage of HMDs to produce thinking abilities has simplified the recognition and recall of similar visual and spatial dimensions. It is critical to focus such studies on these elements so that the stunning VR environment does not interfere with the learning process. According to [29], the usage of VR in education improves students' perception of space but is less effective in gaining precise knowledge.

Psychomotor talents are typically strengthened by consistent practice of anything. Using a head-mounted display (HMD) can help to improve one's psychomotor and learning skills in a computer environment, which can then be applied in the real world. Acquiring VR psychomotor expertise may be more appropriate for higher education, as it normally necessitates more powerful haptic immersion technology. However, it is not acceptable in the educational setting of this study.

According to [30] , VR was most successful in settings that tested or challenged physical experiences. Traveling back in time to historical periods or to inaccessible real-life areas like as space and around the planets was involved [30]. When people fantasise about time travel for educational purposes, history is frequently the first thing that comes to mind. Digital models can be viewed and transferred between historical timelines with ease. It is generally preferable to teach history from many views rather than using specific works from certain perspectives.

Aside from entering practically impossible locales, VR can be used to "fly" to other places, such as foreign countries. For example, using VR to take a virtual field trip to historical sites can help students learn about history. Since it has been demonstrated that VR improves students' understanding of space, it has been an excellent tool for teaching physics, geography, and astronomy.

Virtual reality environments can also be duplicated in standard classrooms or laboratories. Teachers can now see their lessons via a more contextualized, multimedia lens. The VR spectrum may contain an endless number of machines and gadgets of various types employed in various areas. Students are encouraged to practice their skills and learn new techniques in VR environments, but a proper approach is required and emphasized because the physical and virtual environments are not fundamentally the same. VR practice is often safe and easily repeated. Some hazardous or unethical situations and preparation may even be carried out in VR without endangering the user. Dangerous settings, for example, may be more suitable for those in higher education, because safety is heavily emphasized in secondary school.

3 Methodology

3.1 Interview data analysis

Thematic analysis was used to analyze the data since it provided an applicable approach to use across the interviews. Thematic analysis, according to [31], is a "technique for detecting, interpreting, and reporting patterns (themes) within data" (p. 6). A thematic analysis discovered developing themes and what they represented for the issue based on how effectively each person's experiences were comprehended. The interviews were aimed for Omani teachers or educators. An interviewing strategy was chosen to acquire data from selected participants. the study polled 32 teachers. the demographics or characteristics of the participants includes four females and twenty-nine male teachers from various universities in Oman.

Thematic analysis was used in this study to discover common themes. Words, phrases, and similar concepts were discovered after appearing multiple times while reading the transcripts. The data analysis yielded six themes in total: "familiarity with technology, differentiated instruction, student ownership, performance and outcomes, difficulties and barriers, and effective teaching." The term "theme" refers to the degree to which it is logical and accurate to compare one person's statements with those of another. It is reasonable to believe that one person's worldview can be related to that of another. Taking it for granted, as explained here, may appear to be a logical thing to do.

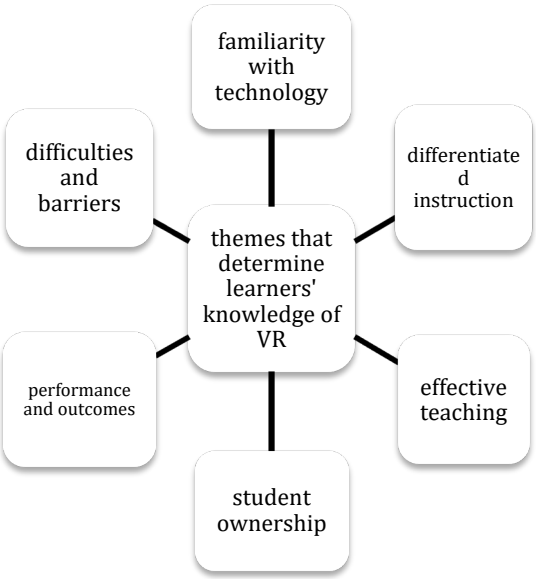

Fig. 1. Themes that determine learners' knowledge of VR

It was vital to highlight that each participant had prior experience with specific types of VR technology. Only individuals with prior expertise with VR technology were chosen for this study; those without such experience were not invited to the interview. As a result, the researcher questioned participants with prior VR experiences prior to performing the interview. The initial round of interview questions was aimed to discover more about the participants' backgrounds, including work titles and gender. The second set of interview questions was created to find broad questions about significant elements of VR for teaching and the objective of technology in education. The remaining six questions were aimed to provide more detailed information about the adoption of VR technology in education. By the end of the interviews, all participants had the opportunity to provide further remarks if they so desired.

4 The themes based on the interview's information

Themes were created based on the information obtained from the interviews. To avoid problems caused by transcribing process misinterpretation, the transcripts were completed manually. Within a few weeks of the last interview, all the transcripts were ready for data analysis (Sapsford & Jupp, 1996). Before developing the final themes, all transcriptions were carefully read numerous times to achieve saturation and to acquire a basic sense of the total data. Reading aided in the choice of keywords, drawing concepts, and documenting some observations that acted as codes. All codes were compared and developed into themes, which were then condensed into larger ones based on the conducted interviews. Six themes have been identified: familiarity with technology;

differentiated instruction; student ownership; performance and outcomes; issues and barriers; and effective teaching. Table provides an overview of the interview questions and resulting themes [31].

Table 1. Overview of Interview Questions and Themes

Interview Questions	Themes
What are important features you like in VR in your teaching?	Familiarity with technology, Effective teaching
What is the goal of technology in education?	Familiarity with technology, Differentiated instruction
What do you think of virtual reality as an instructional tool?	Familiarity with technology, Differentiated instruction
How do you recognize the adoption of virtual reality over other technology learning tools?	Familiarity with technology, Differentiated instruction, Performance and outcomes, Effective teaching
How do you see the adoption of virtual reality in your institution?	Familiarity with technology, Differentiated instruction, Effective teaching
How do you evaluate students' outcomes and performance after the adoption of virtual reality?	Familiarity with technology, Differentiated instruction, Student ownership, Performance and outcomes
What are the barriers and assets in adopting virtual reality?	Issues and barriers
What is the future of virtual reality in education?	Familiarity with technology, Performance and outcomes, Effective teaching

The VR gadget piqued the interest of the lecturers. The majority of lecturers and participants agreed that VR has the potential to capture students' attention. It is a method of attracting students' attention; it appears very appealing, and practically all of them have experience with similar technology or through games. Lecturers, in particular, said that they might use VR to teach specific topics. Furthermore, teachers stated that VR technology appealed to them as a terrific interactive tool for motivating and engaging students. They believed that good teaching must involve students in the learning process while also motivating them to study more. Similarly, VR appears to be capable of incorporating real-life scenarios or locations into lectures. It will alter kids' learning environments. Besides that, instructors agreed on the importance of adopting new technology. Lecturers showed an interest in employing VR technology to make pedagogical content more exciting.

5 Discussion

The primary purpose of the study was to investigate the usage of digital media, with a focus on VR applications, and how this could be successfully adopted in education in Oman. Digital media is a fast-expanding field of knowledge that has the potential to significantly alter students' learning results. VR technology, in particular, is the new educational future. These types of tools (VR) must be integrated into the curriculum.

This study uses a case study to focus on understanding the foundation and structures of VR applications being adopted in several universities in Oman. In particular, VR

shines in circumstances where physical presence becomes unlikely, as physical encounters can threaten human life or even violate the law. During the latest (2020) COVID-19 pandemic, the call for VR has again gained popularity as it protects individuals from physical touch—this makes gatherings, encounters, and events have an impressive atmosphere. Teachers across the globe use VR to send students on augmented journeys, which minimizes loss of motivation due to social alienation, and this majorly involves home-bound learners [32]. The interviews result show that teachers stated that VR technology appealed to them as a terrific interactive tool for motivating and engaging students. They believed that good teaching must involve students in the learning process while also motivating them to study more. The contributions of this study show that VR technology appealed to teachers as a terrific interactive tool for motivating and engaging students. They believed that good teaching must involve students in the learning process while also motivating them to study more. The study includes some limitation as the teachers of the survey analyses found. It found that there are numerous potentials for teachers to employ virtual reality in primary education.

6 Conclusion

The current study was intended to be a case study in which VR technology was introduced to Omani colleges and the ability to use VR as an instructional tool was discovered. This study demonstrated and yielded interesting results.

Based on the information obtained from the interviews. Teachers reported that the adoption process went smoothly because the students had already been exposed to many sorts of technologies in the classroom and in their daily life. In fact, virtual reality (VR) offered a new level of excitement, was interactive, improved pupils' learning, and could engage learners. teachers agreed that they needed to stay up with the new digital environment since the next generation of learners was more receptive of technology than ever before. Furthermore, virtual reality assisted lecturers in supporting learning objectives, improving learners' comprehension, and even taking them beyond prior knowledge levels. While this study yielded interesting results, it does have certain drawbacks. The study mentions a limitation in terms of the findings, which may be limited to the demographics and technology evaluated. And there are numerous potentials for teachers to employ virtual reality in primary education.

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8 References

[1] F. Abdullah and R. Ward, "Developing a General Extended Technology Acceptance Model for E-Learning (GETAMEL) by analysing commonly used external factors," *Comput-ers in Human Behavior,* vol. 56, pp. 238-256, 2016. https://doi.org/10.1016/j.chb.2015.11.036

[2] M. M. Alamri, " Undergraduate Students' Perceptions toward Social Media Usage and Academic Performance: A Study from Saudi Arabia," *International Journal of Emerging Technologies in Learning,* vol. 14, no. 3, 2019. https://doi.org/10.3991/ijet.v14i03.9340

[3] E. Tzagkaraki, . S. Papadakis and M. Kalogiannakis, "Exploring the Use of Educa-tional Robotics in primary school and its possible place in the curricula.," in *Education in & with Robotics to Foster 21st Century Skills. Proceedings of EDURO-BOTICS 2020, Online Conference February 25-26, 2021, 216-229, Switzerland, Cham: Springer.*, 2021. https://doi.org/10.1007/978-3-030-77022-8_19

[4] N. Alalwan, L. Cheng, H. Al-Samarraie, R. Yousef, A. Alzahrani and S. Sarsam, "Challenges and prospects of virtual reality and augmented reality utilization among primary school teachers: A developing country perspective.," *Studies in Educational Evaluation,* 2020. https://doi.org/10.1016/j.stueduc.2020.100876

[5] H.-A. Elliot and L. Joey J, "Virtual Reality in education: a tool for learning in the experience age," *Int. J. Innovation in Education,* pp. 215-226, 2017. https://doi.org/10.1504/IJIIE.2017.10012691

[6] S. M. C. Loureiro, J. Guerreiro, S. Eloy, D. Langaro and P. Panchapakesan, "Understanding the use of Virtual Reality in Marketing: A text mining-based review," *Journal of Business Research,* pp. 100, 514-530, 2019. https://doi.org/10.1016/j.jbusres.2018.10.055

[7] C. W. Shen, J. T. Ho, T. H. Luong and T. C. Kuo, "Behavioral intention of using virtual reality in learning," in *26th International World Wide Web Conference*, 2017. https://doi.org/10.1145/3041021.3054152

[8] C. W. Shen, J. tsung Ho, P. T. Minh Ly and T. chang kuo, "Behavioural intentions of using virtual reality in learning: perspectives of acceptance of informationn technology and learning style," *Virtual Reality, spriger,* 2018. https://doi.org/10.1007/s10055-018-0348-1

[9] I. Ajzen, "The theory of planned behavior," *Organizational behavior and human deci-sion processes,* vol. 50, no. 2, pp. 179-211, 1991. https://doi.org/10.1016/0749-5978(91)90020-T

[10] W. S. Alhalabi, "Virtual reality systems enhance students' achievements in engineering education," *Behaviour & Information Technology,* pp. 919-925,35,11, 2016. https://doi.org/10.1080/0144929X.2016.1212931

[11] G. AlFarsi, R. M. Tawafak, S. I. Malik and B. H. & Khudayer, "Facilitation for Undergraduate College Students to Learn Java Language Using E-Learning Model," *International Journal of Interactive Mobile Technologies,* vol. 16, no. 8, 2022. https://doi.org/10.3991/ijim.v16i08.28689

[12] M. Kalogiannakis, G. Nirgianaki and S. Papadakis, "Teaching magnetism to preschool children: The effectiveness of picture story reading," *Early Childhood Education Journal,* vol. 46, no. 5, pp. 535-546, 2018. https://doi.org/10.1007/s10643-017-0884-4

[13] M. E. Al-Emran, "Investigating attitudes towards the use of mobile learning in higher education. Computers in Human Behavior," vol. 56, pp. 93-102, 2016. https://doi.org/10.1016/j.chb.2015.11.033

[14] M. Al-Emran and V. Mezhuyev, "Examining the Effect of Knowledge Management Factors on Mobile Learning Adoption Through the Use of Importance-Performance Map Analysis (IPMA)," in *International Conference on Advanced Intelligent Systems and Informatics*, 2019. https://doi.org/10.1007/978-3-030-31129-2_41

[15] G. ALFarsi, J. Jabbar and M. ALSinani, "Implementing a Mobile Application News Tool for Disseminating Messages and Events of AlBuraimi University College," *International Journal of Interactive Mobile Technologies (iJIM),* vol. 12, no. 7, 2018. https://doi.org/10.3991/ijim.v12i7.9484

[16] D. Kamińska, T. Sapiński, N. Aitken, Della Rocc, M. Barańska and R. Wietsma, "Virtual reality as a new trend in mechanical and electrical engineering education. Open Physics,," *Open Physics,* vol. 15, no. 1, pp. 936-941, 2017. https://doi.org/10.1515/phys-2017-0114

[17] S. M. Reeves, K. J. Crippen and E. D. McCray, "The varied experience of undergraduate students learning chemistry in virtual reality laboratories," *Computers & Education,* vol. 175, p. 104320., 2021. https://doi.org/10.1016/j.compedu.2021.104320

[18] N. Singh and ,. J. Lee, "Exploring perceptions toward education in 3-D virtual environments: An introduction to Second Life," *Journal of Teaching in Travel & Tourism,* vol. 8, no. 4, pp. 315-327, 2009. https://doi.org/10.1080/15313220903047896

[19] F. Ali, P. Nair and K. Hussain, "An assessment of students' acceptance and usage of computer supported collaborative classrooms in hospitality and tourism schools," *Journal of Hospitality, Leisure Sport & Tourism Education,,* vol. 18, pp. 51-60., 2016. https://doi.org/10.1016/j.jhlste.2016.03.002

[20] L. Jensen and F. Konradsen, "A review of the use of virtual reality head-mounted displays in education and training," *Education and Information Technologies,* pp. 23(4), 1515-1529, 2018. https://doi.org/10.1007/s10639-017-9676-0

[21] G. Fransson, J. Holmberg and C. Westelius, "The challenges of using head mounted virtual reality in K-12 schools from a teacher perspective," *Education and Information Technologies,* pp. 25(4), 3383-3404, 2020. https://doi.org/10.1007/s10639-020-10119-1

[22] N. Vidakis, A. K. Barianos, A. M. Trampas, S. Papadakis, M. Kalogiannakis and K. Vassilakis, "Generating Education in-Game Data: The Case of an Ancient Theatre Seri-ous Game," in *Proceedings of the 11th International Conference on Computer Supported Education (CSEDU)*, 2019. https://doi.org/10.5220/0007810800360043

[23] R. Mathew, S. Malik and R. M. Tawafak, "Teaching Problem Solving Skills us-ing an Educational Game in a Computer Programming Course," *Informatics in Education,* vol. 18, no. 2, pp. 359 -373, 2019. https://doi.org/10.15388/infedu.2019.17

[24] A. Al Musawi, A. Ambusaidi and S. Al-Balushi , " Effect of Using 3-D Lab on Omani Science Students' Achievement.," in *Multidisciplinary Academic Conference*, 2010.

[25] N. A. M. A. H. M. S. C. G. A. Abir Al Sideiri, "CUDA implementation of fractal image compression," *Journal of Real-Time Image Processing,* no. ISSN 1861-8200, p. 15, 24 June 2019.

[26] Z. Cao, J. Jerald and R. Kopper, "Visually-induced motion sickness reduction via static and dynamic rest frames," in *IEEE conference on virtual reality and 3D user interfaces (VR)*, , 2018. https://doi.org/10.1109/VR.2018.8446210

[27] M. Suomalainen, A. Q. Nilles and S. M. LaValle, "Virtual reality for robots," in *International Conference on Intelligent Robots and Systems (IROS)*, 2020. https://doi.org/10.1109/IROS45743.2020.9341344

[28] S. F. Alfalah, "Perceptions toward adopting virtual reality as a teaching aid in information technology," *Education and Information Technologies,* pp. 2633-2653, 2018. https://doi.org/10.1007/s10639-018-9734-2

[29] N. Jeremy, Y. Nick, B. Jim, B. Andrew C, L. Nicole and J. Michael , "The Use of Immersive Virtual Reality in the Learning Sciences: Digital Transformations of Teachers, Students and Social Context," *THE JOURNAL OF THE LEARNING SCIENCES,* pp. 102-141, 2008. https://doi.org/10.1080/10508400701793141

[30] M. J. Kim, K. L. Choong and J. Timothy , "Exploring consumer behavior in virtual reality tourism using an extended stimulus-organism-response model," *Journal of travel research,* vol. 59, no. 1, pp. 69-89, 2020. https://doi.org/10.1177/0047287518818915

[31] V. Braun and V. Clarke, "Using thematic analysis in psychology," *Qualitative research in psychology,* vol. 3, no. 2, pp. 77-101, 2006. https://doi.org/10.1191/1478088706qp063oa

[32] B. M. Gupta and S. M. Dhawan, "The Global Publication Output in Augmented Reality Research: A Scientometric Assessment for 1992-2019," *International Journal of Knowledge Content Development & Technology,* vol. 10, no. 2, pp. 51-69, 2020.

[33] S. Kavanagh, A. Luxton-Reilly, B. Wuensche and B. Plimmer, "A systematic review of virtual reality in education," *Themes in Science and Technology Education,* pp. 10(2), 85-119., 2017.

[34] M. Halaweh, "Model of Emerging Technology Adoption(META): Virtual Reality as a Case Study," *Journal of Information & Knowledge Management,* pp. 1 -18, 2019. https://doi.org/10.1142/S0219649219500205

[35] R. M. M. S. I. &. A. G. Tawafak, "Development of framework from adapted TAM with MOOC platform for continuity intention," *International Journal of Advanced Science and Technology,* pp. 1681-1691(29)1, 2020.

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