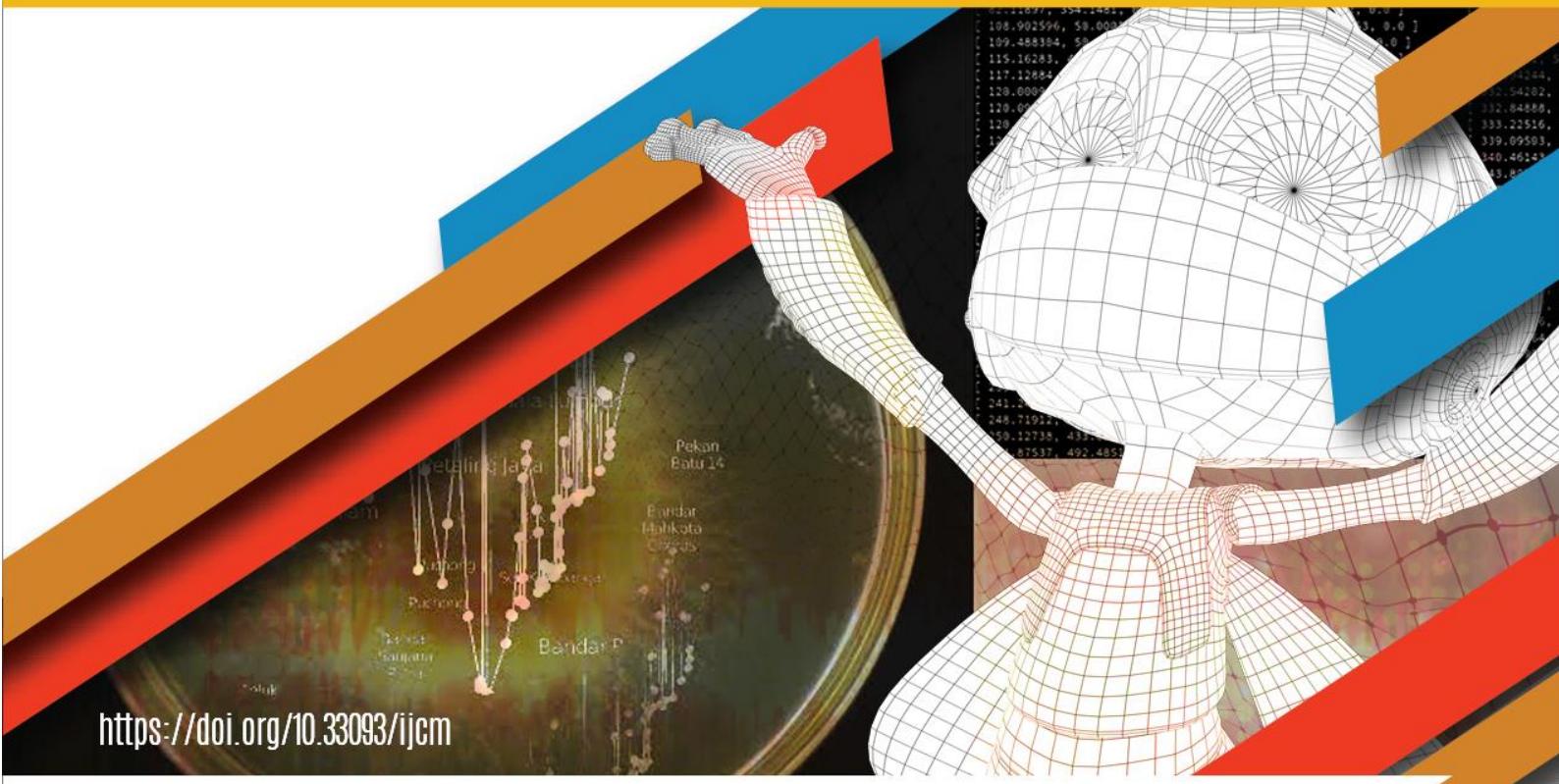
JUNE 2020 VOL. 1 SPECIAL ISSUE

E-ISSN: 2716 6333



https://doi.org/10.33093/ijcm

INTERNATIONAL JOURNAL OF CREATIVE MULTIMEDIA

MMU® MULTIMEDIA UNIVERSITY | UNIVERSITY PRESS

International Journal of Creative Multimedia

Exploring the Use of Immersive Technology in Education to Bring Abstract Theoretical Concepts to Life

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Abstract

Over the years educators have adopted a variety of technologies in a bid to improve student engagement, interest and understanding of abstract topics taught in the classroom. There has been an increasing interest in immersive technology such as Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR). The ability of VR to bring ideas to life in three dimensional spaces in a way that is easy for students to understand the subject matter makes it one of the important tools available today for education. A key feature of VR is the ability to provide multi-sensory visuals and virtual interaction to students wearing a Head Mounted Display thus providing students better learning experience and connection to the subject matter. Virtual Reality has been used for training purposes in the health sector, military, workplace training, gamification and exploration of sites and countless others. With the potential benefits of virtual technology in visualizing abstract concepts in a realistic virtual world, this paper presents a plan to study the use of situated cognition theory as a learning framework to develop an immersive VR application that would be used to train and prepare students studying Telecommunications Engineering for the workplace. This paper presents a review of literature in the area of Virtual Reality in education, offers insight into the motivation behind this research and the planned methodology in carrying out the research.

Keywords Virtual reality; Learning with Technology; Situated cognition

International Journal of Creative Multimedia (2020) 1, 1, 20201107:70-80
doi: https://doi.org/10.33093/ijcm.2020.X1.7

Published by MMU PRESS. URL: https://journals.mmupress.com/index.php/ijcm

Introduction

Educationalists have often sought various approaches to improve the learning experience of students, as research has found that students often report their learning experience to be boring, unengaging, abstract and inapplicable (Mathrani, Christian, & Ponder-Sutton, 2016; Sharp & Hemmings, 2016). The National Association of Independent Schools (NAIS) published the "2014 NAIS Report on High School Survey of Student Engagement" which revealed that 82% of students reported being disengaged in class due to learning materials being uninteresting (NAIS Research, 2015).

The advent of the internet and smartphones have even made traditionally designed classes less engaging as students found social media a tempting distraction when the lessons were not as interesting or relevant to them (Flanigan & Babchuk, 2015). Zachary (2017) mentioned that most teaching methods have not changed to meet the needs of this generation of students who want learning to be fascinating, engaging and relevant. A notable problem faced by students in the classroom is the disconnection between theory-based learning in the classroom and practical application in the real world which results in students not achieving the intended learning outcomes. This is so because theoretical learning method is difficult for students to understand, assimilate and remember (Mathrani, Christian, Ponder-Sutton, 2016). As such, although in recent years there has been an increased adoption of technology in the classroom, most of them have not been designed to allow students to grasp the real-life application of abstract information and theoretical concepts.

With the advancement of technology, some of the issues described above may be addressed when the use of emerging technologies in the classroom is carefully integrated with an appropriate learning theory. Therefore, this research study seeks to explore the use of situated cognitive theory developed by Lave and Wenger (1991) as a framework to develop a Virtual Reality (VR) application and is driven by the following research question: What is the implication of using Virtual Reality in the learning process of undergraduate students? This paper presents an overview of literature on the use of VR in education and the proposed research methodology that will be used.

Literature review

Challenges of Education in the 21st Century

Schmidt, Wagener, Smeets, Keemink, and van der Molen (2015) posits that while conventional lectures are able to aid in the achievement of learning objectives to a certain extent, these conventional forms of lectures "do not promote critical thinking; student attendance tends to be low and so is cognitive

engagement". Schmidt et al (2015) further explains that the key challenge with traditional forms of lectures is that they stem from the idea that telling students something is enough for them to learn. French and Kennedy (2017) argues that lectures do have its merits, such as providing an overview of the subject and being a cost-effective way to teach in a large scale, however they agree that the integration of more interactive forms of learning should be added to offset the shortcomings of lecturers. In recent times, educators have begun changing their roles in the classroom in an effort to move away from being just lecturers. Educators are beginning to understand that students are active learners who would benefit from having lecturers who facilitate their learning as these learning experiences allow students to construct knowledge and attribute individualized meanings to their achievements (Padilha, Machado, Ribeiro, Ramos, Costa, 2019).

Education in this 21st century requires students to be able to understand concepts that are complex or abstract however the most common method used to teach these abstract concepts, especially when it comes to science subjects, is through the use of metaphors and analogies (Chris, 2010). In Malaysia, there has been an alarming drop of interest amongst students in taking up STEM subjects as the perception is that these subjects are dry and boring (Chin, 2019). The Malaysian Ministry of Education has taken several initiatives through the Malaysia Education Blueprint 2013-2025 to change the way educators approach teaching and learning, encouraging the use of more innovative technology and blended learning approaches to increase students' interest in STEM subjects (Ministry of Education, 2012).

Importance of Virtual Reality in Education

One approach that educators are looking into when it comes to redesigning the classroom is the use of immersive technology such as Virtual Reality (VR) in an education setting. VR can be described as a method of visualizing a realistic or imaginary three-dimensional space through the use of various technologies with the possibility of allowing the user to interact within this virtual space (Chris, 2010). Chris (2010) further elaborates, "These environments often depict three-dimensional space which may be realistic or imaginary, macroscopic or microscopic and based on realistic physical laws of dynamics, or on imaginary dynamics." VR can also be defined as the "use of computer technology to create a simulated environment" where the user is immersed into the experience and interaction of this artificially created world rather than looking at it through a two-dimensional screen (Joe, 2019). Immersion in VR can be described as a situation where the user perceives they are immersed into the virtual world (Lin, Hsu, & Shih, 2013).

Research has suggested that VR is potentially a powerful technology that can create learning environments that allow simulations of scenarios, enabling students to experience and visualize these

scenarios (Chris, 2010). Students are able to concentrate better when they experience an immersive virtual 3D environment as it provides a learning experience that is able to maintain their attention and increase their motivation (Wang, Wu, Wang, Chi, & Wang, 2018).

In fact, the potential benefits of using virtual learning environments in the preparation of professionals, such as those in the field of healthcare, has been observed by educators from various disciplines (Davis, 2009). One example of this is the VR app "World of Comenius" which is being used in classrooms to provide students richer educational experiences and also to improve their engagement in the classroom (James, 2014). Figure 1 shows an illustrated example of a VR headset with hand held controllers used to study human anatomy.

Figure 1 Virtual Reality Technology is used to Study Human Anatomy. Creative Commons Licensed Photo by Jesper Aggergaard on Unsplash (https://unsplash.com/photos/38Hg7GMTogo)

Chris (2010) argues that the advantages of VR when it comes to its use in the education field is that VR allows students to observe, experience, and interact with concepts or lessons that would normally be challenging to illustrate through traditional methods.

Spence (2018) quoted Tolson as saying that "Virtual reality will allow students to gain an extra level of experience by visiting and engaging with sites which would otherwise be off-limits to most trainees,". Students from TAFE (Technical and Further Education) South Australia's Tonsley Campus are being taught refrigerant safety courses using virtual technology. The students take virtual tours of hazardous work environment and are taught safety precautions. The virtual training teaches students how to respond as if

they are really on the job site (Spence, 2018). Dr Jacqueline Thomas, as quoted in an article by Brown (2017) mentioned that "experiential, site-based learning is really critical and powerful. VR doesn't replicate a site 100 per cent, but it's taking students places and into environments beyond the classroom.". However, while some have argued that the capability of VR to create a completely realistic experience is still limited by the hardware and software prowess available, when it comes to education, it's not the technology that limits its use but how it is being utilized to enable students to learn (Martín-Gutiérrez, Mora, Añorbe-Díaz, & González-Marrero, 2017). The main objective of using virtual reality is to encourage students to think strategically by creating an environment where they can match their theoretical course work to virtual real-life observations (Brown, 2017). Hence, with increase accessibility and improving technology, VR is potentially able to create opportunities that will allow users to be immersed in experiences that are normally impossible or inaccessible (McCann, 2018).

Situated Cognition Theory

Situated learning as introduced by Lave & Wenger (1991) believes that learning takes place within an authentic activity, culture and context associated with the learning experience. Situational cognitive theory hopes to bridge the gap between abstract theoretical learning and practical application. Proponents of Situational cognitive theory believes that combining relevant authentic activities and context makes learning effective and relevant for students (Brown, Collins, & Duguid, 1989). According to Xinyu (2019) situational learning theory believes that knowledge has context and the learning should be conducted in the corresponding context. Situational cognitive theory believes there is a dynamic interaction between the construction of knowledge by learners depending on the context or situation they are in (Xinyu, 2019). Simply put, students are able to learn better when they are in a situation that allows for the application of said knowledge. Experiencing complex problems that mimic real life situations provides students with a learning experience that allows them to gain transferable skills (Wang & Cheng, 2011). The key principles of situated learning as noted by Lunce (2006) are:

- Presentation of knowledge within an authentic context (a scenario or situation where the knowledge would be applied).
- Learning requires collaboration and social interaction between learners in what is called a "community of practice".
- Tacit knowledge, which is defined as knowledge that is difficult to transfer to another, is assumed to be present.

- The process of learning known as "everyday cognition" to use tools or artefacts to achieve real-world objectives in a real-life situation.

Virtual Reality technology offers a platform for the integration of situated cognitive theory as it is able to stimulate a virtual learning environment where learning is backed up with seeing and doing (Abdi, 2013). Virtual Reality technology provides immersive content that students can use to visualize educational content as it applies to real life scenario, it also provides a platform where students can engage with and replicate learning scenarios as it occurs in real life. The use of VR in an exploratory form of education appears to promote creative thinking, positive attitudes towards learning, and higher motivation as it provides students with a better learning experience (Lin, Wang, Kuo, & Luo, 2017). According to King-Thompson (2018), the ability to view motion graphic images or videos in 360˚allows for learners to form stronger connections in what they are learning as they are able to be immersed in their learning and more engaged within the virtual environment.

Methodology

The methodology for this research study is divided into two parts. Part 1 involves the development of an immersive Virtual Learning application that will utilize a Head Mounted Display and controllers for interaction. Part 2 will be the research methodology. The aim of this research study is to look at designing virtual reality learning applications to bridge the gap between abstract theoretical knowledge taught in the classroom and the skills needed in the workplace. Therefore, situated learning will be used as the pedagogical framework to guide the design of the content and interactive activities in the VR learning application. The plan is to design the VR learning application using telecommunications related content that are hard for students to visualize, with the help of a subject matter expert.

Part 1 – Designing and Developing the VR Learning Application

The goal of the application is to immerse students in the role of a telecommunications engineer and be given various simulated scenarios to problem solve and apply their theoretical knowledge. Using a virtual simulation also ensures that students are in a safe environment to learn from trial and error. One of the modules from a core telecommunication subject offered at Multimedia University which students need to take prior to going for internship will be selected and used in the development of the VR content. The lecturer of the course will be appointed as the subject matter expert (SME) and will be consulted from time to time throughout all stages of the development. The SME will also assist in the selection of topics to be developed into VR modules, ensuring the topics selected consist of challenging theoretical concepts that

can be visualize through the use of VR. The VR application will be designed to ensure that the course learning outcomes/objectives are mapped to the content and interactive activities within the VR application.

The application will be designed to incorporate situated cognition theory as the pedagogical framework and would be developed using different softwares such as 3d modelling applications, graphic manipulation applications and other relevant multimedia content design software. Blender will be used to recreate the telecommunications working environment in a 3-Dimensional (3D) virtual learning environment to simulate real working situations that students would face when they graduate. Blender would be used to model the 3D virtual learning space, characters and avatar, and also to animate the characters in the virtual scenes. Photoshop and substance will be used for texturing the models to give it a realistic fill, unity and visual studio would be used to program the assets, 3D models and characters that will be used in the virtual scenes, unity will be used to deploy the application to oculus rift, HTC Vive and other virtual reality devices.

Once completed, the VR application will be evaluated and reviewed by the SME before proceeding to be beta/pilot tested by a selected group of participants and feedback received will be used to reiterate and modify the application.

Part 2 - Research Methodology

This research will use experimental design to test the hypothesis. The experimental group is exposed and taught with the virtual technology while the control group is taught without the VR learning application. The target scope and sample of this research is undergraduate students from Multimedia University taking a Telecommunications Engineering course. The students would be randomly assigned to the control group and the experimental group for a period of 4 weeks to learn the selected module.

Pre and Post-tests will be prepared with the help of the SME as a way to benchmark student's prior knowledge and to determine if the learning outcomes have been achieved after the treatment. The Pre and Post-tests will consist of multiple-choice questions (MCQs) and have the same questions but in different orders to avoid the memory effect. Students will be given the pre-test at the beginning of Week 1. Students in the control group will then learn the content as they normally would, through the use of lecture slides, notes, and discussion groups. Students in the experiment group will learn the content using the VR learning application. Both groups of students will also have a project to complete within the 4 weeks. After going

through the treatment, they will be given the post-test at the end of Week 4. Both the experimental group and the control group will receive the same pre and post-tests questions.

Other research instruments used will include a 5-point Likert Scale survey questionnaire adapted from related research studies and focus group interviews to solicit qualitative and quantitative feedback from students in order to gauge their perceptions and attitudes towards the VR learning application. Collected data would then be analysed and triangulated to answer the research questions of the study. Figure 2 shows the overall proposed framework of the research methodology design.

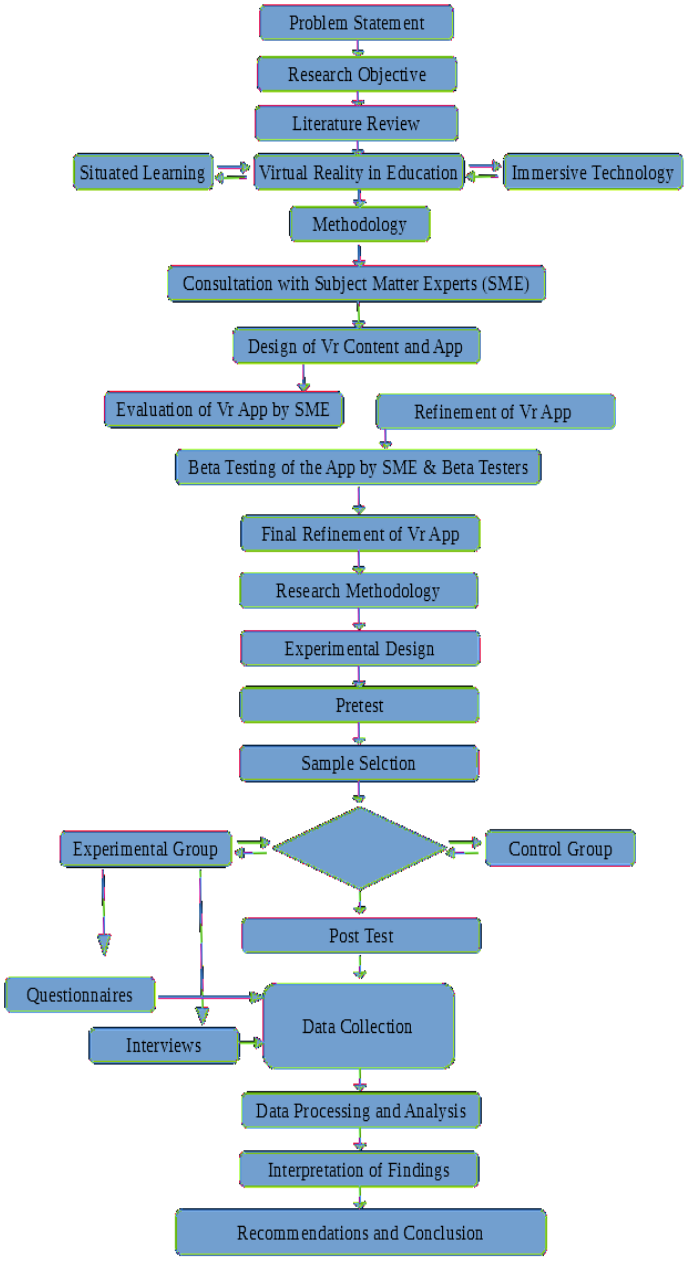

Figure 2 Proposed Research Methodology Framework

Implications and Possible Limitations of the Study

Research has shown that using the right pedagogy in designing a VR app can potentially help to stimulate students' interest in STEM topics. This study hopes to discover if similar results can be attained with Malaysian undergraduate students which may help to provide a basis for further research and development of VR app for educational purposes. It is hypothesized that students in the experimental group will show increased interest, engagement, and motivation towards the topic as the VR app will be able to visualize telecommunication concepts that are usually hard for students to understand. A possible limitation to this study would be the availability and accessibility of VR headsets for all students in the experimental group due to the high cost of purchasing a VR headset. The students involved in this research will have to take turns to use the app to learn the content if there are not enough VR headsets for all. Students also may not have access to a VR headset outside of the classroom which would then limit the usage of the application to within the classroom only.

Conclusion

This paper has presented an overview of the challenges faced by educators when it comes to engaging their students in STEM subjects that tend to be perceived as boring. Various research has found that Virtual Reality technology, when used in the right context, has the potential to help visualize concepts that are abstract and theoretical thus piquing the interest of students and increasing motivation. The research study is still on-going and is currently at the beginning stages of the VR development; therefore, findings and results of the study will be presented in future publications.

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Authors' Bio

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