Ministry of Manpower
Directorate General of Technological Education
Nizwa College of Technology

A RESEARCH PROPOSAL

ON

IMPACT OF WEB-ENABLED GENERATIVE LEARNING MODEL THROUGH IMMERSIVE VIRTUAL REALITY

July 2019

Executive Summary

The rapid and continuous emergence of innovative technologies in ICT during the last decade resulted in disruptions and corresponding innovations in many areas of our society, most notably in education. The maturing and stability of educational technology brought many new learning paradigms that seek heavier and better use of ICT technology to provide different alternative learning experiences on both teachers and students alike. As these technologies become mainstream in educational settings, more and more educational institutions adopt them, which results in better overall learning for students.

One of the most popular emerging new technologies in education is virtual and augmented reality. Although this technology was originally developed for the gaming world, its use to provide learners with simulations of learning scenarios immediately caught on, which paved the way for an abundant possible use in different facets of teaching and learning process. Nowadays, educational institutions started to improve from the usual self-paced slideshow media approach to a more immersive virtual reality approach in lesson delivery. This allows students to experience learning and to be more engaged in the lesson, at the same time, get more understanding of the learning process that happens.

As this technology continues to disrupt and innovate existing pedagogies and paradigms, the authors realized the vast potential it can provide to different levels of educational institutions in the Sultanate. Thus, a research study utilizing case studies approach is proposed, which can provide models for more large scale implementations later on.

The success of this study will provide significant changes in the educational landscape in the country and will steer educational institutions to embrace the 4th Industrial Revolution more freely. Thus, the authors hope that this proposal will be given the opportunity to be realized.

Introduction and Statement of the Problem

Rapid developments in information and communication technologies, as well as fast-paced developments in the fields of computers and mobile devices gave rise to a new and innovative technology - virtual reality. As defined by the Franklin Institute[1], "...virtual reality (VR) implies complete digital immersion experience that shuts out the physical worlds". Although VR was initially developed for the digital gaming world, over time, the technology evolved into other uses, one of the most notable is education.

The popularity and rise of use of educational technology in recent decades gave way to the emergence of more innovative and technology-centric lesson delivery methods. These include e-learning, blended learning and student-centered learning, among others. Aside from offering alternative learning that is more "experiential" in nature in several aspects, these pedagogies also make use of technology to offer a more constructivist approach to learning; one that does not only make heavy use of technology, but also allows learners to explore learning on their own, and consequently, develop and expand knowledge through these self explorations. The rise of various virtual learning environments and learning management systems in recent years also helped educators to easily adopt these same pedagogies and combine them in a single platform to further assist learners in fully embracing the use of a mixture of technologies to abandon traditional ways of learning - memorization and rote learning - and embark on a more engaging, more independent (less assistance from teachers in terms of gaining knowledge), and more experiential, through the use of innovative technologies.

As the use of VR starts gaining traction in mainstream education, it is only logical for educational institutions to begin exploring how this technology can be integrated in their day-to-day operation. As posited by Yuen, et. al.[2], VR facilitates ubiquitous learning and give learners instant access to location-specific information compiled and provided by numerous sources. In this regard, by making use of this technology, learners will be able to facilitate learning anytime they want; gone are the days where teachers are the sole repository of information and knowledge, and learning happens only inside the classrooms THROUGH the teacher. Rather, students now has a better chance to own their knowledge acquisition, which will be sustained by the vast amount of information located in the Web and accessed through various forms of technologies, including immersive VR.

Being one of the premier higher technological education institutions in the Sultanate, Nizwa College of Technology (NCT) leads colleges of technology in the implementation of blended learning and student-centered learning approaches to lesson delivery through its robust, stable and mature implementation of learning

[1] The Franklin Institute. https://www.fi.edu/difference-between-ar-vr-and-mr

[2] Yuen, Steve Chi-Yin; Yaoyuneong, Gallayanee; and Johnson, Erik. (2011) *"Augmented Reality: An Overview and Five Directions for AR in Education"*. Journal of Educational Technology Development and Exchange (JETDE): Vol.4, Iss.1, Article 11.

management system. Having also a flexible and ever-expanding ICT infrastructure, NCT is able to implement heavy use of educational technology in its teaching-learning model through various forms of e-learning and provision of virtual learning environments. As the college continues to mature in its implementation of these technologically-enhanced pedagogies, it is only logical that it also continues to explore better ways of not only utilizing newer educational technology, but more importantly, providing its students with more engaging, more experiential, and in the process, more innovative ways of gaining knowledge and understanding various subject matter. As such, from the current scenario of student-centric teaching-learning model that is supported by a stable ICT infrastructure and a functional learning management system, the college wants to up the ante by introducing, and hopefully, making a college-level implementation of a more "experiential", more engaging learning, through the use of immersive virtual reality; one that will still be supported by its ever-expanding ICT infrastructure and web-enabled virtual learning environment, but at the same time, move one step further for the college in utilizing technology in lesson delivery: through immersive simulation using virtual reality.

In order to bridge the gap between the existing teaching-learning approach and the teaching-learning environment that is sought by the college to be mainstream in the next few years, a pilot study should be made in order to come up with a model, as well as a strategy that will be successful and sustainable for the long term. This model, once successfully realized, can be further extended not only within the college of technology system, but also to the basic education system in the Sultanate, as immersive VR can be a good catalyst to the generative[3] approach to learning, and this more natural form of learning pedagogy can have excellent results to children as well, as children are seen to have the best receptive mechanisms for natural ways of learning, which is the main issue in generative learning approach.[4]

[3] Merlin C. Wittrock (1992) Generative Learning Processes of the Brain, Educational Psychologist, 27:4, 531-541, DOI: 10.1207/s15326985ep2704_8

Roger Osborne & Merlin Wittrock (1985) The Generative Learning Model and its Implications for Science Education, Studies in Science Education, 12:1, 59-87, DOI: 10.1080/03057268508559923

Literature Review

The constructivist theory of education is not a new teaching-learning paradigm; it is actually being used in different educational settings for decades now. However, this approach to teaching and learning remains very relevant in the information age mainly because it allows educators to explore different ways for learners to explore and construct knowledge on their own, with limited participation from teachers. In this regard, the explosion of educational technology, and the

current heavy use of various technology in education provided a very good foundation for these explorations to rapidly grow as well. Thus, there are currently numerous studies on how technologies can be used, and be adopted to come up with various forms of implementing constructivist theories today.

In the paper "Learning Strategies: A New Educational Technology"[5], the author, David Jonassen, highlighted that in the changing landscape of learning, there is a shifting emphasis to give focus on what learners do or require; thus, educational technologies need to become learner-oriented. The author further emphasized that the goal of new technologies in education should be to promote independent, self-motivated learners who are capable of initiating, selecting and using appropriate strategies for acquiring, retaining and using knowledge. Jonassen, together with other authors, further expanded on this by describing assumptions of constructivist epistemology and then contrasting them by objectivist assumptions, and finally describing instructional systems that can support constructive learning in distance education.[6]

In her paper, Lynette Schaverien[7] described the results of a study called Generative Virtual Classroom, a research-based, web-delivered, technology and science education context, which learners (student-teachers) were able to develop the ability to recognize, describe, analyze and theorize the learning that happened during the teaching-learning process using this virtual environment. The author's focus is to use advanced technologies for learning and to bring about large-scale improvements in classroom practice. The results of the study affirmed the worth of

[5] David H. Jonassen (1985) Learning Strategies: A New Educational Technology, PLET: Programmed Learning & Educational Technology, 22:1, 26-34, DOI: [6]10.1080/1355800850220104

David Jonassen, Mark Davidson, Mauri Collins, John Campbell & Brenda Bannan Haag (1995) Constructivism and computer-mediated communication in distance education, American Journal of Distance Education, 9:2,7-26, DOI: [7]10.1080/08923649509526885

Lynette Schaverien (2003) Teacher education in the generative virtual classroom: developing learning theories through a web-delivered, technology-and-science education context, International Journal of Science Education, 25:12, 1451-1469, DOI: 10.1080/0950069032000070234

web-enabled generative systems and the power of biologically-based, generative theory to make sense of the learning that occurred.

In the study by Janet Shepherd, et.al.[3], the authors reported on the fruitfulness of the generative theory and model of learning for making sense of e-learning designs. The authors further recommended to formulate a design process that is generative in nature and to further set out research in this area.

[3] Shepherd, J., Clendinning, J., Schaverien, L. (2002). Rethinking E-Learning Design on Generative Learning Principles.
http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.92.7136&rep=rep1&type=pdf [9]
Parong, J., & Mayer, R. E. (2018). Learning science in immersive virtual reality. Journal of Educational Psychology, 110(6), 785-797.
http://dx.doi.org/10.1037/edu0000241

Meanwhile, the study by Parong and Mayer[9] aimed to compare the instructional effectiveness of immersive virtual reality with that of a self-directed media slideshow for teaching scientific knowledge. Their study found out that although the slideshow fared better in terms of structured tests outcomes, immersive VR produced more interest and motivation for learners, which demonstrate the positive results for engaging learners through generative, immersive approach. The results of this study provided an important value to generative learning strategies in immersive VR environments.

Lastly, the study of Makransky, G., et.al.[4] showed that immersive VR provides that opportunity for learners to act out realistic scenarios, which could help in their further understanding of knowledge acquisition and the overall learning that happens, which in some normal teaching-learning settings would be impractical or impossible to happen.

These studies show that there really is a positive outcome in the use of generative learning and immersive VR in education, and thus, it is important that this can be tested in a higher technological education setting, such as NCT, and then, later on expand it to the basic education setting in select high schools in the Sultanate.

Objectives

The following are the main objectives of this research proposal:

1. To create a generative learning environment by developing a virtual reality laboratory where students learn the topics of a course through an immersive VR simulation environment;
2. To identify and utilize VR components in the delivery of the course;
3. To determine the readiness of the teacher and the students in the use of VR components in the teaching-learning process; and
4. To determine the impact of the generative learning approach using immersive VR technology.

Research Methodology

This research study will involve several approaches to realize its objectives.

Firstly, the study will establish a “Immersive VR Laboratory” where hardware and software components of VR will be configured and setup. In this regard, a set of VR devices (32 VR headsets and 32 workstations) will be configured for the purpose. These VR workstations, once configured with the necessary software, will serve as

[4] Makransky, G; Borre-Gude, S; and Mayer, R. (2019). Motivational and cognitive benefits of training in immersive virtual reality based multiple assessments. Wiley Online Library. https://doi.org/10.1111/jcal.12375

the Immersive VR Laboratory. Each workstation will be individually worn by the students during class to experience simulation of the topic being discussed and studied in the selected class/course for this study. The Immersive VR Laboratory will be used for the delivery of the selected course to pilot the implementation of the study. Once the establishment of the Immersive VR Laboratory is complete, the next stage of the study can be started.

The second phase of the study involves preparing the selected course to be ready for VR-supported delivery. In this regard, the research proponents will discuss with the NCT IT Department and the concerned teacher(s) how immersive VR can be utilized in the delivery of the course and identify the topics that can be made VR-ready. Once this step is complete, the Research Team will proceed to closely work with the teacher(s) of the course to identify which VR app can be used to effectively deliver the course.

Once hardware and software components are setup and ready to be used in the course, the next stage of the process is to familiarize the teacher(s) on how to utilize the technology to deliver VR-supported topics for the course. This involves several training sessions with the teacher, which includes how the teacher will orient the students in the use of VR components during classes.

The first milestone of the project will be measured according to three major deliverables: (1) establishment and setup of Immersive VR Lab; (2) development of VR-ready course; and (3) training the teacher how to deliver the VR-supported topics of the course.

Once the first milestone is achieved, the next step is to start delivering the course. The delivery of the course will be considered a case study. As such, the Research Team will regularly monitor the course delivery by scheduling periodic focus group discussions with students and regular interviews with the teacher(s). In this way, strengths and weaknesses of the implementation and use of VR can be documented, and readiness of the department, teacher and students to this new method can be identified.

Later, a comparative analysis regarding the performance of the students on the outcomes of the course will be done, considering the class that underwent VR implementation, against the other classes that did not. This will determine the impact of using immersive VR in the overall delivery and achievement of course outcomes.

The second and final milestone of this research study will be taken from the results of the readiness of the class in utilizing immersive VR in course delivery and the impact of this implementation in the overall achievement of the course.

Once the implementation is completed at NCT, the whole process can be replicated in the selected high schools. The general procedures for the implementation will be the same; only the VR hardware and the course/class will be different. In the second part of implementation of this research study for high school

students, stand-alone VR headsets will be used, and the course/class where the immersive VR will be used will be selected as the implementation in NCT comes to a close. This will save the Research Team time, as the second half of the implementation can be immediately started once everything is finished at NCT.

In terms of timeline, the following can be used as a general guide for implementation:

a. Procurement of hardware and software and setting-up of the Immersive VR Laboratory (2 months)
b. Identification and testing of required software and other application tools for VR-supported course/class (1 month)
c. Development of other course requirements to be VR-ready (3 - 6 months) **This will be done ONLY if additional course requirements are required to be customized or created from scratch
d. Course delivery (around 3 months)
e. Determination of readiness and identification of overall impact of immersive VR in course delivery and knowledge acquisition (1 month) Following this guide, the implementation of this research study at NCT (1st Stage) is roughly about 1 academic year (10 - 12 months). The 2nd Stage of the implementation in selected high schools can also be of the same time frame.

In total, the whole research study can be completed within two years.

Significance of the Study

This proposed research is significant in the following ways:

1. It will allow learners to have better understanding and comprehension of the topic being studied, as well as a better understanding on how they acquire knowledge and how they undergo learning. As the old adage goes, “I hear and I forget. I see and I remember. I do and I understand.” If students will be subjected or immersed to simulating and “experiencing” the topics they are studying, they will have a more worthwhile and productive learning through better engagement. This way, they will understand the subject matter better. Thus, providing different simulations of the topics or giving students alternative ways of actually experiencing the subject matter being studied will benefit them most in the long term, as it will provide them better comprehension and understanding of the knowledge they gained.
2. By providing an environment wherein learners are given the chance to take ownership of knowledge acquisition through simulators that allow them to experience generative learning, they become independent learners over time. This will not only be beneficial for the learners; it will also be beneficial for the college as these students will become life-long learners that could not only give back to the college after

graduation, but more importantly, they could form part of a new generation of Omani learners that could assist in better nation-building for the benefit of the Sultanate.

3. Through simulating the topics to be learned through immersive VR technology, this study can develop a model to lessen expenditures of educational institutions for physical facilities and equipment. The successful implementation of this model could give rise to "mobile immersive VR simulation laboratories", which will not only save the country's educational institutions large amounts of money for buying physical equipment in learning, moreover, it will catapult the Sultanate's education system into the new generation of learning approaches using innovative technologies.
4. Lastly, this project will allow the Sultanate's educational institutions to keep abreast with the world in adopting the 4th Industrial Revolution, and pioneering it in the educational setting. The success of this research will steer the country's educational institutions to newer approaches and models in the coming years.

Benefits to Oman

As mentioned above, this study will benefit Oman in various ways:

1. The teaching-learning model that can be developed from this study can be replicated in various education sectors and in different levels. This model would include savings in physical equipment and related facilities expenditures, which not only benefits educational institutions, but the government as well.
2. Successful implementation of this study in the HEI level (NCT) and in school level will jumpstart not only a new paradigm in teaching-learning in the Sultanate, but also the embrace of the country in IR 4.0. This will put Oman in the spotlight in the region and in the world, especially if this approach becomes mainstream in Oman's educational institutions.

Budget Summary

Table 1 and 2 shows the components required for the implementation of the research proposal and their associated cost:

Table 1

List of Project Components and their corresponding Budgetary Requirements (Year 1)

No.	Item	Use	Qty	Cost	Amount

1	VR Gadget	To be used by students to simulate course topics	32	150	4800
2	Course App	To be used by the teacher to present course topics during class in VR	1 Lab License	150 per month	1800
3	VR system software	To run VR headsets when used in class	32	15	480
4	VR software	To be used by the	2	300	600
	development kits	Software Developer if additional topics are needed to be customized in class			
5	Information, data collection, presentation, training	Documentation; Presentation in scholarly forums;	1	2000	2000
6	Skills development	Training of teacher to use VR in course delivery	1	800	800
		TOTAL (Year 1)			10480

***All cost and amounts in Rial Omani*

Table 2
List of Project Components and their corresponding Budgetary Requirements (Year 2)

No.	Item	Use	Qty	Cost	Amount
1	VR headsets (stand alone)	To be used by students to simulate course topics	32	150	4800

2	Information, data collection, presentation, training	Documentation; Presentation in scholarly forums	1	2500	2500
3	Travel	Travel to collaborative institution	1	250	250
		TOTAL (Year 2)			7550

***All cost and amount in Rial Omani*

The total budgetary requirement for the research is OMR 18,030 for the duration of two (2) years.

Expected Outcomes

The expected outcomes of this research study are the following:

1. Establishment of a functional Immersive VR Laboratory and a Mobile VR Laboratory;
2. Development of an immersive VR-ready course for tertiary and secondary level students in Oman;
3. Development of a model for successful implementation of generative learning approach using immersive VR technology;
4. Determination of user readiness to web-enabled immersive VR learning approach of tertiary and secondary educational institutions in Oman;
5. Identification of impact of generative learning paradigm and web-enabled immersive VR learning approach to tertiary and secondary educational institutions in Oman.

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[4] Roger Osborne & Merlin Wittrock (1985) The Generative Learning Model and its Implications for Science Education, Studies in Science Education, 12:1, 59-87, DOI: 10.1080/03057268508559923

[5] David H. Jonassen (1985) Learning Strategies: A New Educational Technology, PLET: Programmed Learning & Educational Technology, 22:1, 26-34, DOI: 10.1080/1355800850220104

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