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ANTECEDENTS AND CONSEQUENCES OF USER ACCEPTANCE OF THREE-DIMENSIONAL VIRTUAL WORLDS IN HIGHER EDUCATION

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ABSTRACT

Aim/Purpose	The purpose of this study was to examine the impact of five factors on the user acceptance of Three-Dimensional Virtual Worlds (3DVWs) in higher education. Another objective of the study was to investigate the effects of the application of 3DVWs on five variables relevant to positive outcomes for higher education students.
Background	Three-Dimensional Virtual Worlds (3DVW) are of considerable importance and potential for the creation of the next generation of teaching and learning environments. There has been a remarkable interest in the educational communities in applying virtual environments for teaching and learning, and this technology has been largely adopted to favour educational settings. With the increasing development of 3DVW technologies in the education sector, two uncertainties have emerged with respect to higher education that significantly influence the applicability of the technology in the field: user acceptance of the technology and educational benefits of the technology for both individuals and

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institutions. Thus, this study examined the relationship between various factors and the user acceptance of 3DVWs in higher education as well as the relationship between the application of 3DVWs in higher education and positive educational outcomes.

Methodology: By conducting a quantitative study, an extensive research model was developed by which 21 hypotheses were examined to assess the relationships between 12 variables. In order to evaluate the hypotheses, an online survey with 32 questions was developed and distributed among the participants. The questionnaire was developed to analyse the relationship between independent and dependent constructs of the research model. By applying a purposive convenience sampling technique, 135 undergraduate students, who were enrolled in a first-year elective course, participated in the survey. The PLS-SEM method was used to analyse the relationships between variables based on the hypothesised hypotheses. Second Life was used as the primary 3DVW environment for the research experiment in this study.

Contribution: This study is among the first to conduct a quantitative method by developing an extensive research model to examine both antecedents and consequences of the application of 3DVWs in higher education. The research model examined several self-developed variables relevant to the antecedents and consequences of user acceptance of 3DVWs those had not been defined or examined previously in this field. The study takes 3DVW engagement into account, which is a variable associated with not only use, but also with continuous use of the technology, and deeper involvement with the technology. This study contributes to the research and practitioner body of knowledge by introducing various factors significant in preparing a distance learning environment and activities that can be adapted in higher education.

Findings: The findings suggest the effectiveness of ease of use, usefulness, enjoyment, and visual attractiveness of a 3DVW-based learning environment on user acceptance of the technology. Findings also suggest that application of 3DVWs has a significant impact on student satisfaction, learning outcome, retention, course engagement, and students' graduate outcome. The study confirms that computer self-efficacy of higher education students does not have a positive impact on the acceptance of 3DVWs.

Recommendations for Practitioners: Curriculum designers and developers should consider designing easy-to-use and user-friendly virtual learning environments and should make aesthetic design decisions to create appealing learning environments to attract students' attention. A 3DVW-based learning environment needs to be realistic to make students experience a sense of presence within the environment. Increased enjoyment, pleasure, and playfulness of the virtual learning environment contribute to a higher level of adoption of 3DVWs among students. For the higher education institutions, the costs of developing and maintaining a virtual learning environment and implementing a teaching and learning programme are very low in comparison with a traditional face-to-face education system. This technology provides great capabilities for collaboration, teamwork, and networking on a worldwide scale.

Recommendations for Researchers: Further studies are required to investigate from different perspectives the various factors impacting on user acceptance and/or positive outcomes of user acceptance of the technology. Using the technology for different courses, imple-

	menting different teaching and learning methods, and developing creative activities in the virtual environment might contribute to new findings in the field. This study could be extended by applying the technology in educational settings other than higher education, such as K–12. New studies could also explore other aspects of 3DVWs which were not part of the case study, such as the implementation of the technology on virtual reality, augmented reality, and smartphones.
Impact on Society	The study would be beneficial for higher education institutions worldwide to regulate the key factors that affect students' entrancement of 3DVWs as well as the positive outcomes of user acceptance of this cutting-edge technology for students.
Future Research	This study could be a starting point for future research focusing on various aspects of the application of 3DVW technology in education. Future studies could identify and investigate other variables that are associated with user acceptance of 3DVW in education as well as the positive outcomes of the application of the technology in this field. The four new variables presented in this study can also be examined in different contexts and/or with the application of various technologies. There have been some inconsistencies between the findings of the current study and some of the previous studies in the field. Future studies can investigate inconsistent relationships much more meticulously in a similar context. Future studies could also explore other aspects of 3DVWs which were not part of the case study.

Keywords three-dimensional virtual world, user acceptance, Second Life

INTRODUCTION

A 3DVW is a three dimensional, computer-generated, Internet-based, multimedia, simulated, and graphical environment, usually running on the Web and intended for users to inhabit and interact via their own animated, graphical, and digital self-representations called 'avatars' (Boulos et al., 2007).

Currently, online education and distance learning are growing very rapidly compared to the traditional face-to-face mode of teaching and learning (Norton et al., 2018), and the number of enrolments in online courses has been increasing dramatically. 3DVWs are implemented as online platforms for educating learners in academic and corporate settings and represent a transformational conversion from the traditional classroom to a modern teaching and learning style, allowing learners to achieve knowledge without the time and place constraints (Pellas & Kazanidis, 2015).

As an educational medium, virtual worlds can be utilised to encourage and develop constructive learning among learners. By providing immersive learning environments, this technology enables students to learn various concepts without having explicit learning objectives and assessments. Virtual worlds are worldwide networked environments, and they can be applied in teaching and learning to create societal impacts by bringing students and educators together and challenging them to practice and collaborate in problem-solving activities. Inside virtual worlds, more interaction and engagements can occur without any physical boundaries as the learners experience a sense of presence while immersing within the virtual learning environment (Franklin, 2011).

With an increasing trend of online programs provided by educational institutions, it is crucial to investigate various aspects of emerging Internet-based technologies that can contribute to enhanced teaching and learning. Although many researchers have applied 3DVW technology in the higher education setting for various educational purposes (e.g., Linganisa et al., 2018; Lorenzo-Alvarez et al., 2020), there are gaps in the literature in this field, and further theoretical and empirical research is required. The majority of the studies in the literature focused their attention on the applicability and feasibility of the technology in higher education. Other studies applied the technology for various educational purposes such as holding virtual lectures, virtual labs, discussion boards, field trips, simulation, and other curricular and extracurricular activities. By applying the technology, many studies examined the implementation of different instructional methods and learning theories such as problem-based, collaborative, experimental, experiential, constructivist, didactic, and interactive learning.

Despite the emergence of this technology as a potential mean of education and the growing number of users as well as applications in the field of higher education, there is limited research assessing the user acceptance and adoption of the technology in higher education from various perspectives, or suggesting various factors impacting higher education students' user acceptance of 3DVWs (e.g., Gallego et al., 2016; Merchant et al., 2015). In order to evaluate the construct of user acceptance and to identify the factors that determine user acceptance and adoption of the technology in higher education as a means of teaching and learning, further research is required. Additionally, there are few studies concentrating on the impact of the application of 3D virtual environments on students' positive outcomes (e.g., Vrellis et al., 2016). Studies thus far have introduced a limited number of educational factors that are influenced as a result of the use of technology. The outcomes of the use of this cutting edge technology in the field of higher education require further investigation from different perspectives, and various factors should be introduced to the educational community based on the requirements of today's learners in higher education (Ghanbarzadeh & Ghapanchi, 2018; Pellas, 2014; Pellas & Kazanidis, 2014c).

For instance, Gallego et al. (2016) proposed a model that explains the adoption of Second Life in e-learning and analysed the motivations of application of Second Life in education. Merchant et al. (2015) applied the technology acceptance model to explore undergraduate students' perceptions of Second Life and their intention to use it to learn a chemistry concept. Lorenzo-Alvarez et al. (2020) designed and used a game in Second Life to analyse the students' perceptions of 3DVW and to analyse the medium-term retention of knowledge and the potential impact on the final grades of the students.

The lack of comprehensive studies in the field motivated the authors to study the antecedents and consequences of the acceptance of 3DVWs in higher education. In order to fill the identified gaps, this study aimed at two main objectives and contributions. The first objective of the study was to examine the impact of five factors on user acceptance of 3DVWs in higher education. The investigated factors are perceived ease of use, perceived usefulness, perceived enjoyment, visual attractiveness, and computer self-efficacy. The second aim of the study was to examine the relationship between the application of 3DVWs in higher education and five positive educational outcomes. The variables are student satisfaction, learning outcome, retention, course engagement, and graduate outcome. The study adopted a quantitative approach to test the hypotheses.

To achieve the objectives of the study, a 3DVW-based distance learning virtual environment was designed and developed in Second Life, and an online distance learning programme was conducted in the developed virtual environment for a period of one semester. At the time of the commencement of the study, Second Life was one of the largest and most popular 3DVW platforms which was developed by Linden Lab in 2003. The virtual learning environment included a campus with a variety of buildings and facilities, and a wide range of activities were designed in which students could participate, such as virtual workshops, virtual computer laboratories, discussion groups, orientation programmes, course material, and collaborations. The virtual environment was developed in Second Life and provided all facilities and necessary resources that are required for an online teaching and learning platform. Second Life provides an excellent platform to test the implications of the research model of the current study.

Technology Acceptance Model (TAM) (Davis, 1985) along with two other theoretical models, the updated Delone and McLean IS Success Model (Delone, 2003) and the e-Learning Success Model

(Holsapple & Lee-Post, 2006), are used as the analytical instrument for this research. TAM introduces two main factors: perceived usefulness and perceived ease of use, by which the acceptability of technology by its potential users could be assessed. This method was originally developed based on the Theory of Reasoned Action (TRA).

The remainder of this paper is organized as follows. In the next section, the literature review is described. The third section presents the theoretical foundation and hypotheses development. In the fourth and fifth sections, the research methodology, the data analysis process, and the results of the study are described. We then discuss the findings of the current study as well as practical and theoretical contributions in the next two sections, followed by the conclusion.

LITERATURE REVIEW

3DVWs are of considerable importance and potential for the creation of the next generation of teaching and learning environments. This technology has been largely adopted to favour the educational setting. Over the last decade, there has been a remarkable interest in the educational communities in utilising virtual environments for teaching and learning. 3DVWs support a higher level of interactivity and richness in interaction, collaboration, and communication than traditional media. They have the potential to create engaging and meaningful experiences for learners. As one of the most innovative technologies being used in the area of higher education, 3DVWs provides many potential benefits for both learners and educational communities.

Recently, 3DVWs have become more sophisticated and hold promise to profoundly affect the way individuals communicate and interact. The virtual space can be designed similarly to the real world with real rules, real-time actions, interaction, and communications instead of only illustrations of a fantasy world. In most 3DVWs, the principle rules of physics for environments continue to hold, which makes navigation inside them resemble what one is used to in the real world. They offer the possibilities for simulating the real world or to create new and different dreamy worlds.

As educational institutions apply new technologies, they encounter many uncertainties such as technology adoption, user acceptance, user engagement, proper design for instruction, and appropriate metrics for assessing learning achievement. When a particular technology becomes an advanced and mainstream teaching tool in an area, it is essential to understand the sophisticated aspects of that technology.

With the increasing development of 3DVW technologies in the education sector, two uncertainties have emerged with respect to higher education that can influence the applicability of the technology in the field: user acceptance of the technology and educational benefits of the technology for both individuals and institutions.

Although 3DVWs, as cutting-edge technology and innovative tool, provide enormous benefits for the higher education sector, their application raises questions about their users' acceptance. Many 3DVW-based learning experiences fail because they cannot form a considerable user community that adopts or accepts the technology. Therefore, the factors impacting 3DVW's user acceptance in the higher education sector should be investigated deeply. Venkatesh et al. (2004) defined user acceptance as "a decision made by an individual at a particular point in time in order to use technology intentionally." User acceptance has become one of the critical fundamentals for development and success of a technology, affecting the potential use of the technology by its users. A wide range of studies in the literature have investigated user acceptance of technology in various context. For instance, Estriegana et al. (2019) examined students' acceptance and adopting of an online learning environment. By introducing a comprehensive research model, Park (2020) explored user acceptance of smart wearable devices.

A remarkable number of research studies have been conducted documenting the application of 3DVWs as virtual learning environments in K-12 and higher education, however, a limited number of them have investigated various aspects of 3DVWs such as user acceptance in higher education. For instance, Linganisa et al., (2018), in their qualitative study, investigated the potential and challenges of Second Life as a learning platform. Ahmad and Abdulkarim (2019) investigated some factors that impact the intention to use or not use 3DVW. Another study proposed a model that explains the adoption of Second Life in education (Gallego et al., 2016). Chen et al. (2008), using a quantitative research approach, examined the influence of various factors on students' intention to adopt a 3DVW environment for their educational need.

Assessment of the consequences of applying new technology in a particular context becomes essential for understanding its characteristics, capabilities, benefits, as well as probable issues faced. Researchers have recently become interested in teaching and learning through virtual classroom (Asadi et al., 2019). The interaction and learning experience possible through 3DVW-based classrooms clearly differs from that of a traditional classroom. These environments have a unique blend of 3D space and a wide range of embedded in-world virtual tools and resources, providing the learners and educators with a different style of education. However, the extent to which an educational programme using this technology contributes to actual learning and its beneficial outcomes is questionable. In other words, there is uncertainty about the consequences and potential effects that use of the technology has on positive outcomes for both students and institutions. The extent to which 3DVWs are efficient technology for students and the ways they positively affect education should be thoroughly investigated.

To be able to fill the research gap identified above, this study aims at two main objectives and contributions. The first objective of the study is to investigate the impact of five factors on user acceptance of 3DVWs. The second objective is to examine the effect of applying a 3DVW-based learning approach in higher education on student's positive outcomes consisting of five variables.

A careful review and evaluation of the relevant studies in the literature revealed that there was a lack of studies in the literature focusing comprehensively on the outcome of user acceptance of 3DVW technology in a higher education setting. A limited number of studies investigated the consequences of the use and acceptance of 3DVWs on students' positive outcomes. For example, Vrellis et al. (2016) compared a laboratory problem-based learning activity implemented in both the real and virtual worlds, in terms of learning outcome, student satisfaction, and presence. Masters and Gregory (2010) used a virtual world to investigate the impact on student engagement and learning. Since the second objective of the current study was to identify benefits and advantages of application of the technology in the field of education, the impact of the application of the technology should be measured on a number of variables that could reflect the educational benefits for students (Net benefits based on the learning success model). After a thorough investigation of the net benefits of the use of different technologies in the field of higher education, the study introduces five factors which are categorised as consequences of user acceptance of and the application of 3DVW technology in the context. In a variety of studies in the literature, some of these factors have already been examined and are categorised as the benefits, positive outcomes, and contribution of the use of other technologies in the field of education. Accordingly, some new factors are also introduced in this study that were also aimed to be seen as the net benefits of the application of the technology. Therefore, to be consistent with the current literature, this study aimed at examining the impact of the application of 3DVW on five constructs which are considered as a positive educational outcome.

Parallel research is also being conducted all around the world for the same context, but with the application of different 3D technologies such as virtual reality (VR), augmented reality (AR), and serious games. For instance, Hodgson et al. (2019) adopted VR and immersive VR modes for classroom learning in two undergraduate courses. Elfeky and Elbyaly (2018) investigated the effectiveness of AR in developing higher education students' skills. Willicks et al. (2018) developed status and requirement analysis of the demands of the students on Mixed Reality. Barbosa et al. (2018) developed a serious game in order to promote and demonstrate the applicability of statistics concepts for higher education level students. Future studies could take into consideration the application of similar 3D technologies in higher education.

THEORETICAL FOUNDATION AND HYPOTHESES DEVELOPMENT

The current study applied a quantitative approach to developing a research model to statistically determine the impacts of five independent variables on the user acceptance of 3DVW technology by higher education students. The factors are perceived usefulness, perceived ease of use, perceived enjoyment, attractiveness, and computer self-efficacy. Furthermore, the study examined the relationship between the user acceptance of this technology and five dependent variables relevant to positive outcomes. The dependent variables are student satisfaction, learning outcome, retention, course engagement, and graduate outcome. Due to the significance of some of the previously investigated factors such as student satisfaction and perceived ease of use, they were also included in the research model along with new self-developed factors.

After identifying the gaps in the field, in order to achieve the objectives of the study, the above-mentioned constructs were selected to be examined through a research model for user acceptance as well as the positive outcome. A comprehensive theoretical model was required to fit all of the constructs into it; however, there was no theoretical model in the literature that could cover all of the defined constructs; therefore, three different well-known theoretical models were selected so that they could combine in a way that includes all of the targeted variables. These three models include all of the constructs that were defined to be examined to achieve the objectives of the study.

In developing the research model, the following information system theories and models were studied and applied: Technology Acceptance Model (TAM) (Davis, 1989), updated Delone and McLean IS Success Model (Delone, 2003), and e-Learning Success Model (Holsapple & Lee-Post, 2006). In addition, some self-developed variables were added to the model. The research model examined a number of new self-developed variables and factors relevant to the antecedents and consequences of use of 3DVW in higher education. The new variables are 3DVW engagement, course engagement, and graduate outcome. These are closely relevant to the acceptance and positive outcome of the use of 3DVWs and had not been defined or examined previously in this field, and there was a lack of studies in the literature investigating these factors. To best of our knowledge, the mentioned variables are new in this context, and are examined for the first time in the current study; however, these variables might have been examined in a different context in the literature.

Davis (1989) developed TAM based on the Theory of Reasoned Action, and it is one of the most significant and applied models in the field of IS (Fishbein, 1979). This model is especially important in research exploring the determinants of acceptance of technology. The model is used to predict intention to reject or accept an information system and technology by individuals. TAM suggests that the acceptability of an information system or technology is assessed by two factors: perceived usefulness and perceived ease of use. In the model for this study, these two factors were adapted from TAM.

Delone and McLean's information system success model represents a more integrated conceptualisation of the success of an information system. The model was developed by DeLone and McLean (1992) based on a review of 180 empirical studies. They developed a comprehensive model for information success. This model identified six different constructs that are interrelated and interdependent: "system quality, information quality, use, user satisfaction, individual impact, and organisational impact." Later, by considering e-commerce environment and the original model, they developed the updated model (Delone, 2003). In the updated edition of Delone and McLean IS Success Model, they introduced some different constructs: "information quality, system quality, service quality, use, user satisfaction, and net benefits." This model inspired the main structure of the research model for the current study.

The DeLone and McLean IS success model is adapted by Holsapple and Lee-Post (2006) to develop a success model for e-learning systems. According to this model, success in an e-learning system is defined as "a multifaceted construct that can be assessed along six dimensions including system quality, information quality, service quality, use, user satisfaction, and net benefits occurring in three stages." The positive outcomes of the user acceptance of 3DVWs in the research model for this study were adapted from this model as positive net benefits.

Research Model and Hypotheses Development

The developed research model focuses on two perspectives of application of 3DVW technology in higher education. First, it investigates the impact of five factors affecting user acceptance of 3DVW, and second, the effect of the use of this technology on five factors related to positive outcomes is assessed. Figure 1 shows the developed research model as well as the hypotheses.

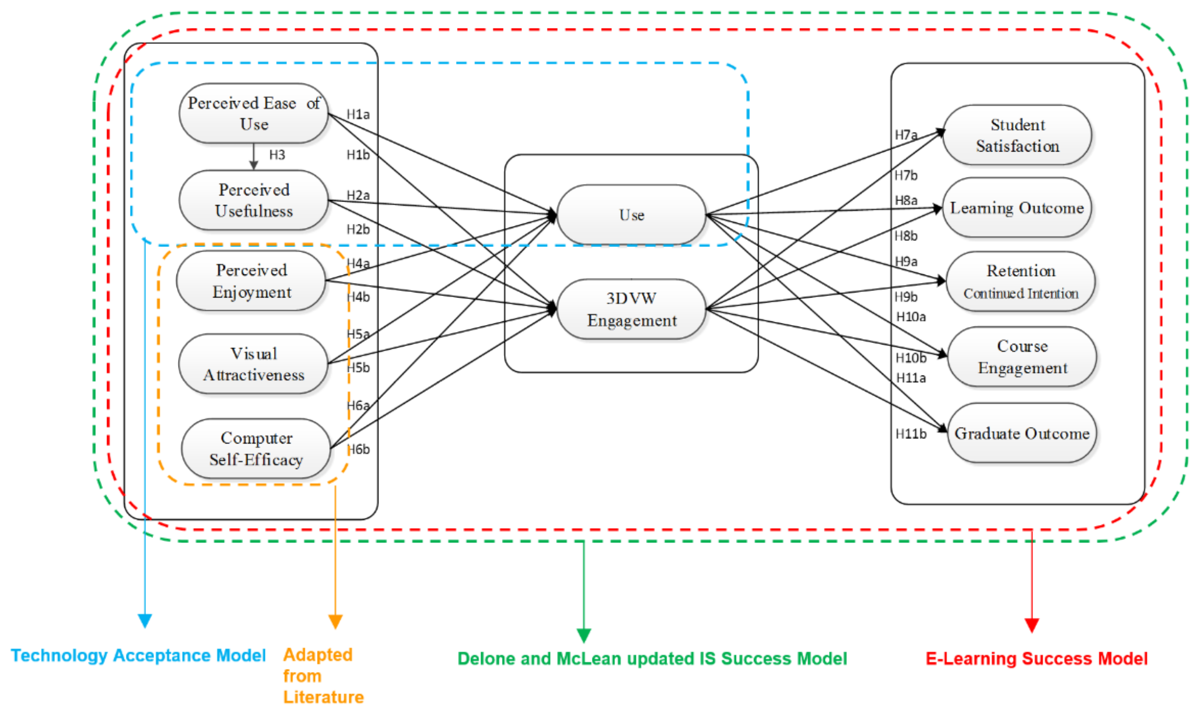

Figure 1. Research model developed for this study and representation of the theories

The basic structure of the developed research model, which consisted of three types of variables, dependent variables, use, and independent variables, was inspired from the Delone and McLean's Updated Information Systems Success Model (Delone, 2003). Similar to the mentioned model, independent factors have relationships with 'use', and similarly, 'use' has relationships with the net benefits. To make the research model compatible with the nature of the technology, the factor of 'user satisfaction' was replaced with a new self-developed factor called '3DVW engagement'.

The e-Learning success model was suitable for this study as it is adapted from the DeLone and McLean IS Success model for e-learning systems. Five independent variables were adapted from TAM and previous studies and placed in the system design part of the eLearning Success Model. 'Perceived Ease of Use' and 'Perceived Usefulness' were adapted from TAM. 'Perceived Enjoyment', 'Visual Attractiveness', and 'Computer self-efficacy' which were adapted from previous studies, were added as factors in the 'System Design' section of the eLearning Success Model.

The five dependent factors were developed as 'Positive Aspects' of 'Net Benefits' in the 'System Outcome' section of the eLearning Success Model. 'Student Satisfaction' and 'Learning Outcome' were adapted from the literature. 'Retention', 'Course engagement' and 'Graduate Outcome' were developed specifically for the current study.

'Use' and '3DVW Engagement' were developed as 'System Delivery' factors based on the eLearning Success Model. In this study, 'Use' is considered as the regular use of the technology in the learning process based on a scheduled timetable as a part of the learning program, whereas, '3DVW engagement' refers to a high level of interest in the technology among students which leads them to use it mindfully, with cognitive effort, and with deep processing.

Research Hypotheses and Theoretical Support

This section outlines the research hypotheses and provides theoretical support for the hypotheses from the literature.

Definition of 'use' and '3DVW engagement'

Different aspects of the use of a system, such as the intention to use, attitude towards use, and actual system use, have been studied in the literature. A wide range of studies have proven that attitude towards the use of a system can have a positive impact on the behavioural intention to use that system. Many other studies have proven that behavioural intention to use a system can have a positive impact on the actual system use. In this research, these three variables are combined and considered as one single variable, called 'Use'. Figure 2 represents the relationship of various constructs to 'use' in detail.

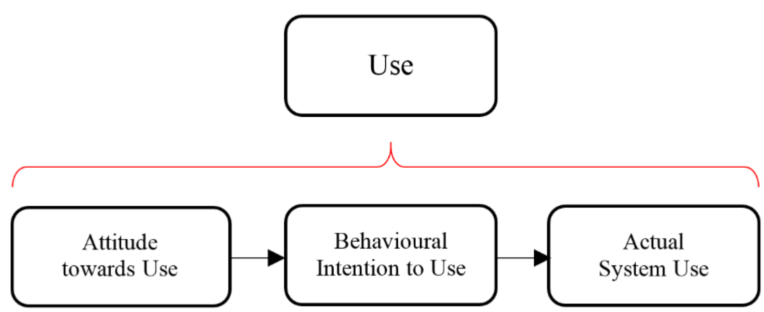

Figure 2. Explanation of the 'Use' variable

The main focus of the model is on the use of 3DVWs which is defined as "a student's use of one or more features of a 3DVW-based learning environment to do a task in relation to his/her education." This factor represents the students' regular use of 3DVW, according to the provided weekly timetable during a specific time period.

Online activities provide opportunities for interaction in virtual worlds. They may also increase students' motivation and engagement (Pellas & Kazanidis, 2014b). Defining engagement is very complex, and there have been various definitions proposed in the literature. For example, Zhoc et al. (2019) defined student engagement as "students' psychological investment in and effort directed towards learning and educationally purposeful activities that contribute directly to desired outcomes." Learner engagement is defined by Deng et al. (2020) as "the behavioural, cognitive, emotional and social connections that MOOC participants make with the course content, the instructor and/or other learners." Schuetz (2008) defined engagement as "a state of interest, mindfulness, cognitive effort, and deep processing of new information that partially mediates the gap between what learners can do and what they actually do." Pellas and Kazanidis (2014a) defined engagement in virtual worlds as "the level of interaction with other users that is achieved, the level of feedback from the virtual environment, and the level of engagement that promoted from various learning activities."

For the current study, in line with Schuetz (2008) and Pellas and Kazanidis (2014a), *3DVW engagement is defined as a state of interest, mindfulness, cognitive effort, and deep processing of 3DVW environment which promotes a strong relationship between the student and the technology*.

In this study, use and 3DVW engagement are considered as two different aspects of user acceptance of 3DVW in the context of higher education.

Hypotheses and theoretical background

The developed research model seeks to explore the following hypotheses.

Hypotheses 1, 2, 3: According to TAM (Davis, 1989), two beliefs are the primary drivers of acceptance of a technology: perceived usefulness and perceived ease of use. Perceived usefulness is defined as "the degree to which a person believes that using a particular system would enhance his or her job performance." Perceived ease of use is defined as "the degree to which a person believes that using a particular system would be free of effort" (Davis, 1989). According to Davis (1989), perceived usefulness and perceived ease of use affect an individual's attitude towards using a system. Perceived ease of use also positively affects the perceived usefulness, and external variables influence both these constructs.

Users of 3DVW-based learning environments need to see it as an easy to use and a useful media which can enhance their learning outcome, contributing to various learning achievements and better communication with their instructors, classmates, colleagues, and other students within a virtual environment. In line with TAM (Davis, 1989), it is believed that perceived usefulness and perceived ease of use will affect a user's acceptance of 3DVW in higher education. TAM also recommends that users who perceive any IS as easy to interact with, find it useful in meeting their needs. Therefore, if a system provides easy functions for users, they will find it beneficial. In a 3D virtual educational environment, we predict this relationship to hold also. In other words, the easier a 3DVWs-based virtual environment is to use, the more useful it would be for its users. Thus, we posited that:

H1: Perceived ease of use will have a positive impact on:

a) use of 3DVWs

b) 3DVW Engagement

H2: Perceived usefulness will have a positive impact on:

a) use of 3DVWs

b) 3DVW Engagement

H3: Perceived Ease of Use of 3DVW will have a positive impact on its perceived usefulness

Hypothesis 4: Perceived enjoyment has been defined and used widely in the literature. For instance, based on definitions of Davis et al. (1992) and Koufaris (2002), M.-C. Lee (2010) stated that "perceived enjoyment as an intrinsic motivation has been found to have a significant impact on a technology acceptance, especially for hedonic systems." Users of technology will be motivated to accept the technology intrinsically if applying that technology creates fun and pleasure for them (M.-C. Lee, 2010). Perceived enjoyment of virtual reality is defined by J. Lee et al. (2019) as "the degree to which the user perceives the use of a VR device to be enjoyable," and perceived enjoyment of Internet of Things (IoT) is defined by Hsu and Lin (2018) as "the extent to which a person believes that using IoT services would provide pleasure and personal satisfaction." In line with the existing literature, for the current study, *perceived enjoyment is defined as the extent to which the activity of using 3DVW technology is* *perceived to be enjoyable for students*. As 3DVWs brings entertainment and enjoyable functions for students, they can regularly gain pleasure while utilising the technology. It was anticipated that perceived enjoyment of use of 3DVW will improve users' acceptance of this technology. Therefore, it is hypothesised that:

H4: Perceived Enjoyment will have a positive impact on:

a) use of 3DVWs

b) 3DVW Engagement

Hypothesis 5: The effect of the visual appeal of IS on the perceptions and behaviour of users has been investigated by many researchers in various contexts (Verhagen et al., 2009). For example, Van der Heijden (2003) introduces the visual attractiveness variable as "the degree to which a person believes that the website is aesthetically pleasing to the eye" and assumes that "aesthetics play a role in the decision to use an information system, especially a website." Yang et al. (2016) showed that visual attractiveness of a wearable device positively affects the perceived enjoyment and social image. The study of S. T. Wu et al. (2020) shows that visual attractiveness has a positive impact on perceived usefulness of augmented reality. These reasons can be extended to 3DVW, as this technology supports the design and development of visually attractive environments with the aim of providing game-like experiences for students. Based on the definition by Van der Heijden (2003), *visual attractiveness is defined as the degree to which a person believes that a virtual environment is aesthetically pleasing to the eye*. This factor refers to the virtual environment's visual effects and elements, graphical structure, colours, patterns, and its overall view. It was expected that the visual attractiveness of a 3DVW-based learning environment is positively associated with the use and engagement of the environments in a higher education context. Accordingly, we hypothesised:

H5: Visual attractiveness will have a positive impact on

a) use of 3DVWs

b) 3DVW Engagement

Hypothesis 6: Bandura (1986) defined self-efficacy as "people's judgments of their capabilities to organize and execute courses of action required to attain designated types of performances." In the field of IS, computer self-efficacy is related to the self-assessment of a person's ability to use computer-related skills in order to perform specified tasks (Compeau & Higgins, 1995). Compeau and Higgins (1995) defined computer self-efficacy as "the degree to which individuals believe they can accomplish difficult tasks using a computer." In the current study, *computer self-efficacy is defined as the degree to which students believe they can accomplish tasks in 3DVW-based learning environments using a computer*. Quite a few studies in the literature have found that there is a relationship between computer self-efficacy and use of information systems. For example, H.-H. Yang (2007) found that computer self-efficacy impacted attitude towards the use of a system. Arfat et al. (2018) found that computer self-efficacy has a positive impact on continuous intention to use e-government services. Computer self-efficacy was included in the research model since the use of 3DVWs involves the use of computers. In line with the current literature, we hypothesised that computer self-efficacy is positively associated with the use and engagement of 3DVW-based learning environments. Thus, we posited that:

H6: Computer self-efficacy will have a positive impact on

a) use of 3DVWs

b) 3DVW Engagement

According to Delone and Mclean's IS Success Model as well as the e-Learning Success Model, there is a relationship between the use of a system and the net benefits. In the current research model, five dependent variables were developed as the net benefits of the application of 3DVWs in higher education: student satisfaction, learning outcome, retention, course engagement, graduate outcome. The hypotheses related to the use and engagement in 3DVW and the above five factors as net benefits of the application of 3DVW in higher education are presented next.

Hypothesis 7: Satisfaction is defined by Oliver (1997) as "the consumer's fulfilment response. It is a judgment that a product or service feature, or the product or service itself, provided a pleasurable level of consumption-related fulfilment." Stuntz (2020) defined student satisfaction as "measurement of how satisfied a student was with the course; including the content, design, and delivery." Adapted from Astin (1993), Alruwath (2015) defined student satisfaction as "the student's perceived value of his or her educational experiences at an educational institution." Researchers have widely cited students' satisfaction as the measure of the effectiveness of various e-learning systems. For instance, the studies of Yilmaz (2017), Pham et al. (2019), Alqurashi (2019), Hew et al. (2020) and many other studies in the literature can be mentioned. In line with the definition by Alruwath (2015) as well as the study by Ghabarzadeh and Ghapanchi (2020), for this study, *student satisfaction was defined as the students' perceived value of their educational experiences through a 3DWV-based virtual environment at an educational institution*. Saba (2012) investigated the impacts of actual system use of a specific e-learning system on student's satisfaction. Thus, in line with Saba (2012), we attempt to investigate the impacts of use and engagement of 3DVWs on students' satisfaction. Thus, we hypothesised:

H7:

a) Use of 3DVWs will lead to a higher level of student satisfaction

b) 3DVW engagement will lead to a higher level of student satisfaction

Hypothesis 8: Saadé et al. (2007) defined the learning outcome as "the observed results in connection with the use of learning tools" which can be measured with "performance improvement, grades benefit, and meeting learning needs." Panigrahi et al. (2018) defined learning outcome as "the measure of the effectiveness of a learning platform." Novak et al. (2019) defined learning outcome as "a statement of what a learner knows, understands and is able to do upon the completion of a learning process." Students' learning outcomes have been widely cited in the literature as measures of the effectiveness of various e-learning systems. For instance, Ewais et al. (2020) used data mining to align learning material and assessment with learning outcomes in MOOCs. Selzer et al. (2019) analysed the relationship between the virtual presence and the learning outcome of students in a virtual reality-based education system. In line with the definition by Saadé et al. (2007), in this study, *the learning outcome is defined as the observed results in connection with the use of 3DVWs*. To investigate the effects of use and engagement of a 3DVW-based learning environment on students' learning outcome, we posited that:

H8:

a) Use of 3DVWs will have a positive effect on the learning outcomes of students

b) 3DVW engagement will have a positive effect on the learning outcomes of students

Hypothesis 9: Retention is widely cited by researchers in the literature, including uncertain and often conflicting results (Berge & Huang, 2004). The majority of research address retention in relation to completion versus non-completion of a degree. Villano et al. (2018) defined retention as "students who remain enrolled at university; they do not discontinue through formal administrative processes nor do they lapse their enrolment where the student fails to undertake any units of study which count towards a degree." Mostafa (2019) defined student retention as "the intention of the student to remain in the same university from first year to graduation." DeVilbiss (2014) defined retention as "the process of retaining or continuing to enrol students at the same institution from one semester to the next and from one year to the next." Based on the definitions of retention provided by DeVilbiss (2014), Berge and Huang (2004), and Ghabarzadeh and Ghapanchi (2020), in this study, *retention is defined as continued student participation in a 3DVWs-based learning programme for another course in addition to the current course*. Therefore, it was hypothesised that:

H9:

a) Use of 3DVWs will have a positive effect on retention

b) 3DVW engagement will have a positive effect on retention

Hypothesis 10: Many studies described 'engagement' as a multi-dimensional phenomenon, and many of them defined engagement with behavioural and affective components. For instance, based on the study by Mosenthal (1999), "engagement is grounded in the cognitive and affective systems of learners and readers." Further studies stated that engagement has an interpersonal element, and students' interaction with other students and instructors can be considered a part of engagement (Connell & Wellborn, 1991; Guthrie & Anderson, 1999). Hew (2015) found that the more students are active within a course, the more engaged they are with the course. Pellas and Kazanidis (2014a) stated that a framework of engagement should validate three concepts of behavioural, emotional or affective, and cognitive factors. Sun et al. (2014, p. 237) defined engagement as "the extent to which a learner is cognitively, emotively, and behaviourally involved in or committed to a learning activity or goal." Based on the study of Skinner et al. (2009), Sirakaya and Cakmak (2018) defined course engagement as "the active participation of students in learning activities in their classes." According to the study by Sun et al. (2014), *course engagement is defined in this study as the degree to which students are cognitively, emotively, and behaviourally involved in or committed to learning activities related to an enrolled course within a 3DVW-based educational environment.* According to the above definition, course engagement is a measure of participating actively in various parts of a course within a 3DVW-based educational environment. Thus, we hypothesised:

H10:

a) Use of 3DVWs will have a positive effect on course engagement of students

b) 3DVW engagement will have a positive effect on course engagement of students

Hypothesis 11: The graduate outcome focuses on the effects of using the 3DVW technology on students' education, resulting in their skill learning, future career, and professional field. It was believed that the use of 3DVW-based learning environment would have a positive impact on students' future career. The graduate outcome can be considered as "the knowledge and proficiency that students achieve in accordance with their future career and professional field" (Ghanbarzadeh & Ghapanchi 2020). Based on the above definition, and for the current study, *graduate outcome is defined as the effects of using the 3DVW technology on students' education, resulting in their skill learning, future career and professional field*. Therefore, it is hypothesised that:

H11:

a) Use of 3DVWs will have a positive effect on the graduate outcome of students

b) 3DVW Engagement will have a positive effect on the graduate outcome of students

RESEARCH METHODOLOGY

RESEARCH DESIGN

An online virtual distance learning programme was conducted using a developed virtual environment for a period of one semester. First, a course was selected for the experiment that had a reasonable number of students from a variety of study backgrounds and disciplines. Then the course's contents, learning activities, and interactions were reviewed and defined. Since all the contents, topics, and activities could be implemented in an online learning platform, and the course could be delivered through a distance learning program, it was a suitable choice for this study. The facilities and capabilities of Second Life were investigated, and it was approved that this platform had all capabilities to be used as a mean of teaching and learning for the course.

Next, the main activities such as lectures, workshops, discussions boards, and course material access were determined for delivering the unit in accordance with the course contents. Then, a 3D environment was designed to implement each of the main activities, and, accordingly, the actual virtual campus with buildings and other facilities were developed by the research team. All of the course resources were gathered, and, in some cases, the format of the resources was changed to a more suitable format for the 3DVW-based teaching and learning, then uploaded to relevant locations within a virtual building called the resource room. For instance, students were given access to all course material in a variety of format. A lecture theatre for delivering lectures and laboratories for conducting workshops were designed. All lectures were recorded and made available to students through the resource room.

At the beginning of the semester, a 30-minute training session was held to introduce Second Life and the environment, facilities, and instructions to students. During this training session, the performance of the system at the peak login time was tested. In the session, students were asked to create an account on Second Life and select a personalised avatar for themselves. Their account name included their name plus their student number and their avatars had to be female or male representing their gender.

For example, one of the major activities in the programme was holding computer labs. A number of computer workshop sessions were held virtually in the 3DVW learning environment. All workshops were conducted for two days a week. The workshops were tutored by five different tutors in which 10-15 students participated in every workshop. At the peak time, there were four simultaneous workshops being held on the virtual environment. Students were given a timetable for their virtual sessions throughout the semester. For each session, students had to log in to the Second Life, teleport their avatars to the virtual campus, and attend their relevant virtual lab. The contents of the workshops were presented by tutors within virtual computer labs by using virtual slide shows inside the virtual labs, and by using voice or text messages through an in-built messenger via Second Life. Students were able to start a discussion with their tutors and/or other students.

Another example activity was the student discussion programme. According to specific timetables, several discussion and consultation opportunities were provided for students in the virtual discussion room in order for them to meet their tutors and lecturer based on a weekly programme in the virtual campus. The sessions included exam and assignment consultation opportunities for students who had questions regarding their final exam or were unclear about their assignments, or if they wanted further guidance.

There were other collaborative activities as well for students to do in groups in the virtual discussion room. The activities were part of students' class exercises and were designed and developed in a way that students were required to discuss the topic with others in the group and then submit their own answers individually.

As mentioned earlier, another feature embedded in the virtual learning environment was the accessibility of all course material for the students. Various resources related to the course, such as videos, presentations, documents, book chapters, lecture captures, and so on were uploaded into the virtual environment so that students could access the materials in an integrated place.

Additionally, there were activities defined for students during the experiment such as course orientation programme, socialization program and intercultural communication, student collaboration, and in-world internet browsing. Table 1 shows various tasks and activities that have been implemented in the course of the study, along with their virtual location and a brief description of each task.

Table 1. Summary of implemented educational task

Task	Virtual location	Task Description
Virtual laboratory	Computer labs: Replicas of a real computer laboratory with virtual laptops connected to the Internet with the necessary software installed on them, presentation display, chairs, and desks	The main activity of computer labs was performing group discussions. According to a specific timetable, students were asked to attend a virtual computer lab. A topic/question was given to them by the instructor, and they started to discuss and post their answers and opinions and ideas about the given topic in the online discussion forum.
Meeting and discussion	Discussion rooms: rooms with five seats and a table suitable for meetings and consultations	Weekly meetings and consultation sessions were regularly available for students and the teaching team to get together in the designated discussion room to discuss course topics.
Course material	Resource room: a building with various rooms housing all relevant course material	In the resource room, students were able to access and download updated course materials 24/7 in various formats such as videos, animations, slideshows, documents and so forth.
Course orientation	Orientation area within the virtual campus	There was a designated area for course orientations inside the campus. Five animated lady avatars were helping students giving extra information about course contents, workshop activities, assignments, exam, and so on with announcements.
Socialization and intercultural communication	Virtual Campus	There were plenty of opportunities for students to socialize and for their interactions and intercultural awareness during the workshops, meetings etc.
Student collaboration	Computer labs and discussion room	Students had to work on their assignments in groups of 4 to 5. Therefore, activities were designed and developed in a way that students in a team could contact each other and complete the task in a team.
In-world internet browsing	Browser billboards	Internet browsers were available in a billboard format so that everyone in the virtual environment was able to have unlimited access to the Internet while they were on the virtual campus.

Case study

The context of the current study is a large undergraduate subject on Informatics offered by an Australian university. This was a first-year elective course, and students from a variety of study backgrounds and disciplines were enrolled in this course (mainly from various branches of the Business discipline). This course was the only course involved in this experiment.

For the purpose of this study, the online virtual distance learning programme for the above-mentioned course was held for a duration of one semester in 2015.

The next section describes various features of the developed virtual learning environment.

Environment under study

Second Life platform was used as the primary mean of education for this study. At the time of conducting this study, Second Life was one of the most popular 3D platforms for teaching and learning with 40 million user accounts, 600,000 active users, and over 700 educational institutions augmenting their curriculum with it (Linden Lab, 2013). Although Second Life has some costs for educational institutions, it is free for individuals, and is a highly adaptable three-dimensional platform and a potential immersive learning environment. By providing visualization, simulation, role-playing experiential learning, and user-created contents, it offers all necessary tools and facilities for establishing a virtual distance learning program.

Second Life provides opportunities for collaboration and social interaction by utilizing various forms of communication such as chat room, private message, and audio and video conferencing, for both students and educators; therefore, it amplifies learning and teaching beyond capabilities afforded by other online platforms, and teleconferencing and web presentation tools. Additionally, there are opportunities available for flexible and self-paced learning, which suits various learning styles, problem-solving, field trips, and integrating blended learning systems. Therefore, this platform was selected to implement the virtual environment and to conduct the case study.

In order to create a virtual environment specifically for this research, a virtual land was rented within Second Life to build the online environment, buildings, and other facilities. The plan was to design a realistic virtual environment to simulate an educational space for students and instructors so that they could virtually attend the virtual learning environment using their avatars and participate in the online distance learning programme.

The virtual environment was designed and developed by the research team for the purpose of this study by exploiting the advanced features offered by Second Life. To create the virtual learning environment and the activities, the Second Life's building tool and Linden Scripting Language (LSL) was utilised. Within the virtual environment, different facilities, buildings, and rooms such as a lecture theatre, four computer laboratories, a resource building with three rooms, a meeting room, and five discussion rooms were developed.

Computer labs were designed to hold lectures, workshops, and collaborative activities such as group discussions. These virtual labs were replicas of real computer laboratory environments with virtual laptops that could be connected to the Internet, presentation display with the ability to present lecture slides, chairs with automatic seating option for avatars, and desks. These labs were designed to provide a collaborative group learning experience. Students in the collaborative learning sessions were able to discuss, express their opinions, and make decisions about a specific topic. The main activity of computer labs was conducting group discussions. According to a specific timetable, students were asked to attend a computer lab virtually inside the campus. They logged into the environment, navigated their avatar towards the computer lab, and took a seat. A topic was shown on display or posted to a discussion forum by the tutor. After, students started to discuss and post their opinions and ideas about the given topic in the discussion forum.

Another environment aimed at facilitating access to the course material and resources was the resource room, a virtual building housing all material for the course such as lecture slides, book slides, sample quiz questions, videos, and other documents. This building consisted of four rooms: assignment room, quiz room, lab/lecture room, and videos/articles room. There were virtual screens in each room that had been programmed to show various material mainly in a video format. Additionally, clicking on the material icons enabled the students to watch and download the class materials. Students were able to access the provided course material in various formats such as videos, animations, slideshows, documents, and so on 24/7. The files were stored in a cloud memory linked to the visual objects in the rooms.

The discussion room was designed to support collaborative and interactive activities for students. Students could contact educators and interact with them individually to receive consultations and help. Discussion boards and consultations were the activities held in this place. There were partitions for group discussions and a large meeting hall for other group activities. Students were able to use voice or text messaging to communicate with each other.

Another area in the virtual environment was the main lecture theatre created to hold lectures with a large number of students. This place was equipped with a large screen to present slideshows and videos. Students virtually attended the lecture theatre according to a timetable by navigating their avatars to the venue which was located at the middle of campus. There was a possibility of speaking in the lecture theatre by using a microphone and speaker. Figure 3 shows screenshots of some of the areas and buildings in the virtual environment.

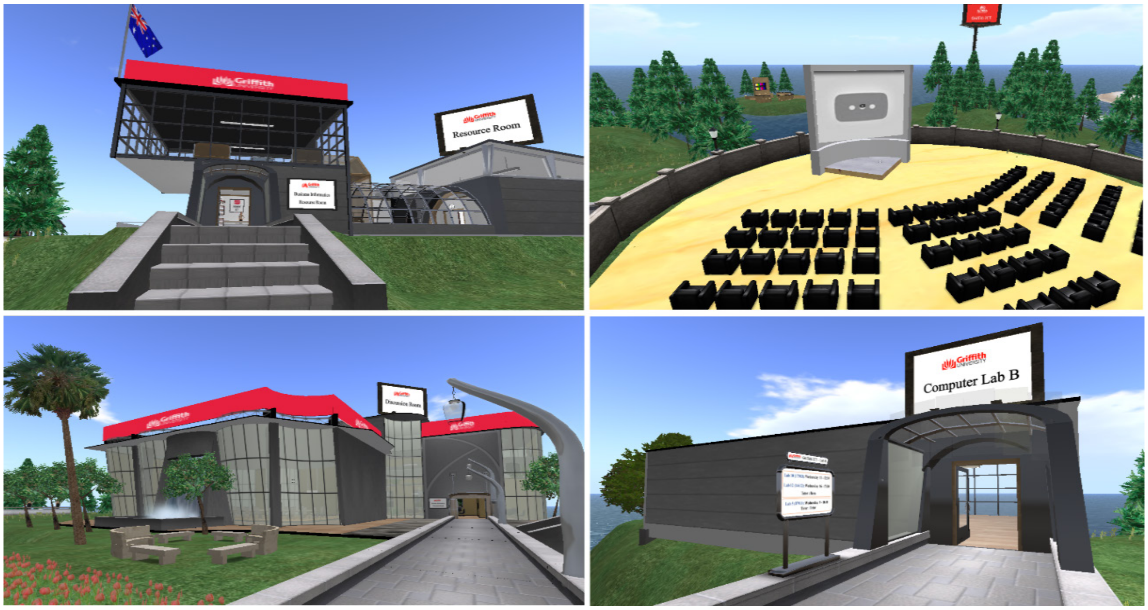

Figure 3. Screenshots of different buildings on the virtual environment

SAMPLE

The sampling technique used in the study was purposive convenience sampling. Two hundred fifty higher education students and academic learners who enrolled in a bachelor's degree course were invited to participate in the study. All students used the Second Life-based learning environment for their course throughout the semester. Participants were from a variety of disciplines, and all of them had the basic information technology knowledge and necessary skill to interact with Second Life. The participants' age varied from 17 to 24 years, and 63% of participants were male, and 37% were female; Table 2 demonstrates demographic information about the participants. Out of 250 enrolled students, 135 students completed the survey and participated in the study (54% response rate).

Table 2. Demographic information of the participants in the quantitative study

Total number of enrolled students	Number of participating students	Number of female participants	Number of male participants	Mean age
250	135	49	86	20.05

MEASUREMENT

Research instrument

A survey was the data collection method for the study. It was used to analyse the relationship between constructs impacting the use of 3DVWs by higher education students and the effects of the use of it on students' positive outcomes. The associated technique for the survey methodology was a questionnaire in this study. To evaluate the research hypotheses, a questionnaire, with 32 questions, was developed according to the research model. The questions on the questionnaire were concept-based which apply variables from different theories, and they were mostly adapted from previous studies in the field, with some self-developed questions. In developing questions for the questionnaire, the relevant instruments in the literature were reviewed and evaluated carefully. A number of indicators for the constructs of the model were selected from the reviewed questionnaires. The indicators were initially recognised by reading their associated definitions. First, a pool of indicators was created. Then the similar indicators in the pool were consolidated, some of them were merged, and the repeated and less irrelevant indicators were removed. After that, a number of questions were developed for each of the self-developed constructs in accordance with the definition and nature of each construct. The questions were reviewed and revised for a few times until the questions were finalised.

The questionnaire analyses the participants' level of agreement with different questions based on a Likert scale approach (Matell & Jacoby, 1971). The answers were created on a five-point Likert scale, where '1' was 'strongly agree', '2' was 'agree', '3' was 'neutral', '4' was 'disagree', and '5' was 'strongly disagree'. The Appendix shows the constructs, questions, and references for each item on the questionnaire.

DATA COLLECTION

Students were given the developed survey and were asked to complete it as an electronic questionnaire at the end of the semester. An online questionnaire system (www.surveymonkey.com) was selected to present the questions to the students. The survey instrument included two sections: (A) an informed consent letter to present the research summary, the expected benefits of the research, participants' confidentiality, risks to participants, agreement to participate voluntarily and privacy statement; (B) the questionnaire. If the participants responded to most of the survey questions, that survey was considered complete. Otherwise, if the participants failed to answer more than 50% of survey questions, it was considered incomplete and not included in the final pool of results. Altogether, 135 students completed the survey. After the data collection was completed, statistical analyses were run on the collected data to examine the hypotheses.

ETHICAL CLEARANCE

The participation of students in the survey was entirely voluntary, and answering the questions was optional, and students could refuse to answer the questions. Filling out the forms did not impact the students' individual assessment in any way, and it did not affect their grade or any other part of their study. The students participating in the survey could withdraw at any point after starting the survey without repercussions. Participants answered the questions in the questionnaire anonymously, and the answers were recorded anonymously. Neither name nor identity of students was asked or recorded during the survey. Before starting the questionnaire, the students were shown information regarding the consent for the survey, in the format of an informed consent form. This study has received approval from the Human Research Ethics Committee.

ANALYSIS AND RESULTS

DATA ANALYSIS

In the data analysis phase, first, a data preparation process was carried out in order to determine how to deal with missing data. In cases where 50% or more questions were missed, the corresponding dataset was removed from the analysis. The 'Mean Replacement' approach was performed for cases with missing data.

In order to analyse the collected data for the study, the Structural Equation Modelling (SEM) implementing Partial Least Square (PLS) was applied. SEM has the capability of analysing all paths in one regression analysis (B. Wu & Zhang, 2014). PLS uses a component-based approach for the estimation (Karahanna et al., 2006). By applying PLS, the analysis of the structural model and the measurement model is possible.

The two-step procedure recommended by Anderson and Gerbing (1988) was used to evaluate the fitness of the proposed model. Firstly, the measurement model was examined in order to assess the reliability and validity of measures. Next, the structural model was tested to assess the strength and direction of relationships between the variables. SmartPLS software version 3.0 (Ringle et al., 2015) was utilised for modelling and estimation of parameters (to analyse both structural and measurement models).

EXAMINING THE MEASUREMENT MODEL

Table 3 presents the construct reliability and convergent validity. Cronbach's alpha scores of at least 0.7 indicate strong internal reliability of each construct, which means that the survey items selected for each construct are reliable measures. Additionally, all standard factor loading (λ) values obtained in the CFA of the measurement model exceeded 0.8, and they were significant at $p \leq 0.001$. Moreover, composite reliabilities of constructs ranged between 0.874 and 0.975, and AVE ranged from 0.743 to 0.951, with both exceeding the suggested threshold of 0.70 demonstrating modest levels of internal consistency. Based on the above values, all of the three conditions for convergent validity were met. In terms of the model's fit indices, NFI and SRMR are 0.812 were 0.047, respectively.

Table 3. Construct reliability and convergent validity

Construct	Questionnaire item	Factor Loading	Cronbach's Alpha	Composite reliability	Average Variance Extracted
Perceived Ease of Use	PEU1	0.814	0.829	0.897	0.743
	PEU2	0.893			
	PEU3	0.878			
Perceived Usefulness	PU1	0.945	0.950	0.967	0.908
	PU2	0.960			
	PU3	0.954			
Perceived Enjoyment	PE1	0.943	0.921	0.950	0.864
	PE2	0.933			
	PE3	0.913			
Visual Attractiveness	VA1	0.922	0.926	0.953	0.871
	VA2	0.952			
	VA3	0.925			
Computer Self-Efficacy	CSE1	0.943	0.868	0.918	0.789
	CSE2	0.903			
	CSE3	0.814			
Use	USE1	0.894	0.712	0.874	0.776
	USE2	0.868			
3DVW Engagement	ENG1	0.922	0.910	0.943	0.847
	ENG2	0.927			
	ENG3	0.911			
Student Satisfaction	SS1	0.936	0.809	0.911	0.837
	SS2	0.893			
Learning Outcome	LOUT1	0.861	0.827	0.897	0.744
	LOUT2	0.910			
	LOUT3	0.814			
Retention	RET1	0.975	0.949	0.975	0.951
	RET2	0.976			
Course Engagement	CE1	0.919	0.803	0.910	0.835
	CE2	0.909			
Graduate Outcome	GOUT1	0.906	0.895	0.934	0.826
	GOUT2	0.914			
	GOUT3	0.907			

Table 4 presents the construct inter-correlations as well as the square root of AVE for each of the twelve constructs in the measurement model. As can be seen from the table, in all cases, the square root of the variance has exceeded the corresponding construct correlations, satisfying the criteria for discriminant validity.

Table 4. Correlation matrix and discriminant validity

Construct	3DVW Engagement	Computer Self-Efficacy	Course Engagement	Graduate Outcome	Learning Outcome	Perceived Ease of use	Perceived Enjoyment	Perceived Usefulness	Retention	Student Satisfaction	Use	Visual Attractiveness
3DVW Engagement	**0.92**											
Computer Self-Efficacy	0.288	**0.888**										
Course Engagement	0.584	0.245	**0.914**									
Graduate Outcome	0.417	0.277	0.612	**0.909**								
Learning Outcome	0.622	0.308	0.731	0.584	**0.863**							
Perceived Ease of use	0.42	0.422	0.227	0.261	0.34	**0.862**						
Perceived Enjoyment	0.792	0.313	0.578	0.389	0.56	0.477	**0.93**					
Perceived Usefulness	0.78	0.264	0.529	0.32	0.556	0.534	0.75	**0.953**				
Retention	0.772	0.283	0.591	0.397	0.518	0.403	0.779	0.74	**0.975**			
Student Satisfaction	0.811	0.248	0.701	0.481	0.735	0.467	0.8	0.755	0.754	**0.915**		
Use	0.572	0.296	0.395	0.274	0.496	0.464	0.482	0.478	0.494	0.498	**0.881**	
Visual Attractiveness	0.486	0.179	0.383	0.289	0.344	0.16	0.488	0.358	0.402	0.432	0.279	**0.933**

FINDINGS

To evaluate the predictive validity measures, the structural model was tested. Twenty-one hypotheses were examined collectively by applying the SEM approach. To examine the significance levels of all the paths, a bootstrap re-sampling was carried out on the structural model (N = 500).

Table 5 demonstrates the results of the structural model. Path coefficient indicates the strength of the relationships.

Table 5. Summary of hypothesis testing

Hypotheses		Path coeffi-cient	t-Value	p-Value	Signifi-cance	Sup-ported
H1a	Perceived Ease of Use → Use	0.246	2.574**	0.011	(p≤0.01)	Yes
H1b	Perceived Ease of Use → 3DVW Engage-	-0.049	0.771	0.441		No
H2a	Perceived Usefulness → Use	0.163	1.239	0.216		No
H2b	Perceived Usefulness → 3DVW Engage-	0.445	4.925***	0.000	(p≤0.001)	Yes
H3	Perceived Ease of Use → Perceived Useful-	0.534	6.397***	0.000	(p≤0.001)	Yes
H4a	Perceived Enjoyment → Use	0.179	1.269	0.206		No
H4b	Perceived Enjoyment → 3DVW Engage-	0.406	4.041***	0.000	(p≤0.001)	Yes
H5a	Visual Attractiveness → Use	0.080	0.734	0.464		No
H5b	Visual Attractiveness → 3DVW Engage-	0.129	2.028*	0.043	(p≤0.05)	Yes
H6a	Computer Self-Efficacy → Use	0.079	0.885	0.377		No

Hypotheses		Path coeffi-cient	t-Value	p-Value	Signifi-cance	Sup-ported
H6b	Computer Self-Efficacy → 3DVW Engage-	0.041	0.638	0.524		No
H7a	Use → Student Satisfaction	0.050	0.844	0.399		No
H7b	3DVW Engagement → Student Satisfaction	0.782	16.215***	0.000	($p\leq0.001$)	Yes
H8a	Use → Learning Outcome	0.208	2.524**	0.012	($p\leq0.01$)	Yes
H8b	3DVW Engagement → Learning Outcome	0.503	5.468***	0.000	($p\leq0.001$)	Yes
H9a	Use → Retention	0.078	0.992	0.322		No
H9b	3DVW Engagement → Retention	0.727	11.618***	0.000	($p\leq0.001$)	Yes
H10a	Use → Course Engagement	0.090	1.052	0.294		No
H10	3DVW Engagement → Course Engagement	0.533	5.520	0.000	($p\leq0.001$)	Yes
H11a	Use → Graduate Outcome	0.053	0.449	0.654		No
H11b	3DVW Engagement → Graduate Outcome	0.378	2.673	0.008	($p\leq0.001$)	Yes

*** Significant at 0.05**
**** Significant at 0.01**
***** Significant at 0.001**

Hypotheses 1, 2, 3: As depicted in Table 5, perceived ease of use significantly impacted the use (path coefficient = 0.246; t-value = 2.574; $p \leq 0.01$). Perceived ease of use also impacted the perceived usefulness significantly (path coefficient = 0.534; t-value = 6.397; $p \leq 0.001$), meaning the data supported both H1a and H3. In other words, students who perceived the virtual learning environment as easy, used it. Moreover, participants who perceived 3DVW as an easy to use technology, found it useful for their education.

The relationship between perceived ease of use and 3DVW engagement (H1b) was not supported as the t-value and path coefficient were 0.771 and -0.049, respectively. Similarly, the relationship between the perceived usefulness and the use (H2a) was not supported in the current study (t-value = 1.239 and path coefficient = 0.163).

Perceived usefulness had a significant effect on the 3DVW engagement (H2b) (where the path coefficient = 0.445, t-value = 4.925, and $p \leq 0.001$). Thus, the usefulness of a 3DVW-based virtual learning environment has a positive impact on 3DVW engagement.

Hypothesis 4: The relationship between the perceived enjoyment and the 3DVW engagement (H4b) was supported in the current study, and it is statistically significant at the 0.001 level (path coefficient = 0.406, t-value = 4.041) indicating that having fun and enjoying the 3DVW-based learning environment increases students' engagement with the technology. Therefore, students who perceived the virtual environment as enjoyable were engaged in this technology, thus supporting hypothesis H4b.

Hypothesis H4a, which hypothesises a positive effect of the perceived enjoyment on the use, was not confirmed (path coefficient = 0.179 and t-value = 1.269).

Hypothesis 5: This study shows that the visual attractiveness had a significant impact on 3DVW engagement (H5b) (path coefficient = 0.129; t-value = 2.028; $p \leq 0.05$). As a result, developing a visually attractive virtual learning environment will contribute to higher technology engagement among higher education students. The impact of the visual attractiveness on the use (H5a) was not supported in the current study (path coefficient = 0.080 and t-value = 0.734).

Hypothesis 6: Hypotheses H6a and H6b were not supported in the study. Therefore, the relationships between computer self-efficacy and use or 3DVW engagement were not confirmed, with t-values of 0.885 and 0.638, respectively. Having computer knowledge does not necessarily impact the user acceptance of 3DVWs among students.

Hypothesis 7: The impact of the 3DVW engagement on student satisfaction (H7b) was supported ($p \leq 0.001$). According to the results (path coefficient = 0.782 and t-value = 16.215), engagement with 3DVWs significantly increased higher education students' satisfaction with the virtual learning environment, however, use of 3DVWs did not have a significant impact of students' satisfaction (H7a). Therefore, the relationship between use and student satisfaction was not confirmed in the current study (path coefficient = 0.50 and t-value = 0.844).

Hypothesis 8: Hypotheses H8a and H8b were supported. Use positively and significantly impacted learning outcome (H8a) (path coefficient = 0.208; t-value = 2.524; $p \leq .01$). Similarly, 3DVW engagement significantly impacted students' learning outcome (H8b) (path coefficient = 0.503; t-value = 5.468; $p \leq 0.001$). This indicates that any form of application or involvement in the 3DVW-based learning environment has a significant effect on the students' learning outcome.

Hypothesis 9, 10, 11: According to path coefficients of 0.078, 0.090, and 0.053 as well as t-values of 0.992, 1.052 and 0.449, respectively for hypotheses H9a, H10a and H11a, it is clear that the impact of use on retention, course engagement and the graduate outcome was not confirmed in this study. This indicates that only casual use of the technology by students without engaging in it did not contribute to any positive outcome, except learning outcome (H8a).

Engagement in 3DVW environment affected the retention (H9b) (path coefficient = 0.727; t-value = 11.618; $p \leq 0.001$). It means that being engaged with this technology positively affects the level of retention among higher education students. Impact of 3DVW engagement on the course engagement (H10b) and graduate outcome (H11b) were also supported (path coefficient = 0.533 and 0.378; t-value = 5.520 and 2.673; $p \leq 0.001$). Therefore, being engaged with 3DVW influences higher education students' course engagement and graduate outcome.

DISCUSSION

The findings of the study show that, except for perceived ease of use (H1a), the relationship between the other four constructs and the use was not supported in the study (H2a, H4a, H5a, and H6a). The relationship between perceived ease of use and perceived usefulness was supported (H3). There was, furthermore, a positive impact of perceived usefulness, perceived enjoyment, and visual attractiveness, on 3DVW engagement (H2b, H4b, and H5b). There was no strong relationship between the perceived ease of use or computer self-efficacy, and 3DVW engagement (H1b and H6b). Although the relationship between use and learning outcome was supported (H8a), the relationship between use and the other four factors—student satisfaction, retention, course engagement, and graduate outcome (H7a, H9a, H10a, H11a)—was not supported in the study. Based on the findings, relationships between 3DVW engagement and all of the five consequence factors were supported (H7b, H8b, H9b, H10b, H11b).

The perceived ease of use, which indicates the ease of use of the virtual learning environment in a higher education context, has a significant impact on the use (H1a), whereas the impact of the factor on 3DVW engagement has not been supported (H1b). A reason for this result would be that for students who only used the technology on a casual basis, but did not use it continuously and did not engage in it, the easiness of the environment was important, as they preferred using a simple and easy tool to only perform the required tasks or attend a class in the virtual environment, whereas for students who were interested and engaged in technology, the hardness or easiness of the technology was not a significant factor. This means that the more the students engaged in the technology, the less the easiness or hardness of the technology was important for them. On the contrary, when students used the technology for a limited time and did not establish a strong relationship with it, the easiness or hardness of the interactions with the environment was an important factor. The relationship supported by H1a is in accord with a variety of studies in the literature such as TAM (Davis, 1989) and TAM2 (Venkatesh & Davis, 2000).

The positive impact of the perceived ease of use on the perceived usefulness is also supported by the study (H3), indicating the fact that easiness of the technology impacts its usefulness positively. This relationship has been supported by a wide range of studies in the literature in the field of education, and the finding is consistent with the existing literature (e.g., Al-Emran et al., 2020; Estriegana et al., 2019; Joo et al., 2018). Significance of the hypothesis H3 also confirms the findings of the TAM (Davis, 1989) and TAM2 (Venkatesh & Davis, 2000) models.

According to the results, perceived usefulness has a significant impact on 3DVW engagement (H2b). This relationship has not been examined in the literature previously. The influence of the perceived usefulness on the use was not supported (H2a). This result indicates that for students who had a casual use of this technology, usefulness was not an effective and important factor; therefore, the usefulness did not affect the use of the system. However, for participants who were engaged in this technology, usefulness was a significant factor. As they cognitively formed a deep relationship with the technology, the usefulness of the learning environment influenced their engagement and increased their acceptance of the technology. In other words, their perception of the usefulness engaged them more to use and engage with the technology. The more the student perceived that the usefulness of the technology was important for their education, the more they were engaged in the technology. This finding also can be interpreted differently—the more a 3DVW-based learning environment is useful, the more students accept it. The results show the significance of usefulness of a virtual learning environment and its contents in order to achieve adequate user acceptance rates.

H2a, which was not supported in the current study, did not confirm the findings of the TAM (Davis, 1989) and TAM2 (Venkatesh & Davis, 2000) models. However, this is in accord with the findings of many studies in the literature such as Tahar et al. (2020) and Oum and Han (2011) which did not find any significant effect of the perceived usefulness on the intention to use new technology. This result indicates that the usefulness of an information technology does not always lead to the intention to use or attitude towards the use of the system. Therefore, the perceived ease of use and the perceived usefulness have an impact on different aspects of user acceptance of 3DVW. Perceived ease of use impacts the use of the technology positively, whereas perceived usefulness impacts the engagement in the technology positively.

According to the findings, perceived enjoyment has a significant impact on 3DVW engagement (H4b). This relationship has not been examined in the literature. The study did not support the impact of perceived enjoyment on the use (H4a), which is in accord with a variety of studies in the literature such as Agrebi and Jallais (2015), Venkatesh et al. (2003), and Mun and Hwang (2003) who found that the perceived enjoyment has no direct effect on the intention to use, therefore, this finding is not in line with the findings of Van der Heijden (2004), which support that perceived enjoyment is a determinant of intentions to use of information systems. H4b indicates that performing enjoyable activities in the 3D virtual environment by the students contributed to the creation of a deep relationship with the technology. The more students enjoy the environment, the more they are engaged to use the technology over time. In other words, perceived enjoyment does not necessarily have a strong effect on the casual use of the technology (H4a), but rather it leads to engagement and continuous use of the technology and creates for the students a deep involvement with the technology.

Similar to perceived enjoyment, visual attractiveness also has a positive impact on 3DVW engagement (H5b) which has not been examined previously. The positive impact of visual attractiveness on the use was not supported by the current study (H5a), which is not in line with the findings of Van der Heijden (2003) and Verhagen et al. (2009). Having visually attractive features in the virtual learning environment positively affects the students to accept the technology and creates a deep relationship contributing to a continuous use with engagement. Attractiveness does not contribute to only the casual use of the virtual learning environment, but it establishes a cognitive attempt and feelings of engagement among higher education students.

The relationship between computer self-efficacy and the use was previously confirmed by many studies in the literature (e.g., Lew et al., 2019; Mensah & Mi, 2019; Verhagen et al., 2009); H.-H. Yang, 2007). Contrary to our prediction, the effect of computer self-efficacy on the use (H6a) and 3DVW engagement (H6b) has not been supported by this study. This indicates that having knowledge of computers and not having computer anxiety does not affect user acceptance of the 3DVWs in higher education. An explanation for this result would be that our participants were from a young generation and were younger students, mostly aged around 18 to 20, and they generally had a basic knowledge of computers and have grown up with computers and this knowledge is a part of their basic literacy, and they already possess computer skills. Additionally, they are aware of the advantages of using technology in their personal lives as well as in their studies. Consequently, computer anxiety does not exacerbate their condition when they use it or are engaged in new computer-based technology. Learners these days have a high usage of ICT-based technology such as desktop computers, laptops, smartphones, and other electronic devices. Therefore, having computer self-efficacy does not necessarily contribute to user acceptance 3DVW, and students do not consider computer self-efficacy an important facilitator in using 3DVW. These findings are consistent with the findings of some studies in the literature such as Shiau and Chau (2016) who found that computer self-efficacy has no significant impact on the intention to use and actual use of technology in education, respectively. To best of our knowledge, H6b has not been tested previously in the literature.

The findings for 3DVW engagement confirm the primary predictions of the current study. This factor significantly influences all five predefined dependent factors (H7b, H8b, H9b, H10b, H11b) which indicates that when students are interested in the technology, and use it mindfully, with cognitive effort, and with deep processing, they will establish a strong relationship with the technology, which contributes to a higher level of student satisfaction, enhances student learning outcomes, increases student retention and course engagement, and positively impacts on graduation outcomes. However, the use of 3DVW technology without engaging with it had no significant impact on the positive outcomes defined. The relationship between use and learning outcome was supported by the current study, meaning that the application of the technology helps students to achieve better learning outcomes. The relationship between use and the other four factors was not supported in this study, meaning that only casual use of the technology will not have positive outcomes for higher education students. In order to achieve positive outcomes, students should be engaged in 3DVW technology, using it continuously and cognitively.

PRACTICAL AND THEORETICAL CONTRIBUTIONS

This study has made several contributions to the body of knowledge in the field of research. The main focus of the study was on the user acceptance of the technology, specifically in higher education. According to the findings, a limited number of studies in the literature studied on user acceptance of 3DVW technology specifically in higher education; the previous studies have mostly investigated factors and variables different from those were investigated in the current study. The study attempted to take one step forward and investigate the consequences of the application of the mentioned technology in higher education.

The majority of studies in the field mainly investigated the ‘use’ of 3DVWs in the education context, whereas this study was aimed to take ‘3DVW engagement’ into account which is a variable associated with not only use, but also with continuous use of the technology, and deeper involvement with the technology.

By conducting a quantitative study, an extensive research model was developed by which 21 hypotheses were examined to assess the relationships between 12 different factors. The model has a rich theoretical background as it has employed three significant information system theories and models, TAM (Davis, 1989), updated Delone and McLean IS success model (Delone, 2003), and e-learning success model (Holsapple & Lee-Post, 2006). The current study also implements information system theories and concepts in the education literature.

The research model examined several self-developed variables relevant to the antecedents and consequences of the application of the technology in higher education that had not been defined or examined previously in this field. For instance, variables such as 3DVW engagement, course engagement, graduation outcomes, and retention (this factor is defined differently in the current study) are novel and self-developed variables that were employed for the first time by the current study.

IMPLICATIONS FOR PRACTICE AND SOCIETY

The study has a number of implications for various practitioner groups including, educators, study designers, and virtual world developers, in addition to the higher education institutions, universities, colleges and polytechnics, online universities, and other educational communities.

Implications for curriculum designers and developers

As confirmed by hypothesis H1a, designing an easy-to-use virtual learning environment and including simple options in the environment helps students immediately learn the features of a virtual environment; this contributes to the acceptance of the technology.

According to the result of hypothesis H5b, the virtual world designers should make aesthetic design decisions to create an appealing learning environment to attract students' attention. Different elements, such as visual effects, graphical structure, multimedia features, colours, patterns, and the environment's overall view, are important factors when creating a virtual learning environment.

To achieve a better teaching and learning outcome, the 3DVW-based learning environment would be better to be designed and developed in a realistic way, so that stimulates student's sense of presence.

Including game-like activities in the learning environment, developing game-based learning, and equipping the virtual environment with exercises that can increase enjoyment, pleasure, and playfulness contribute to a higher level of adoption of 3DVWs by students (as per hypothesis H4b).

Most of the 3DVW platforms provide building tools and programming languages to fill in the gaps left by the platform engine. Programmers and developers are able to customize, modify and improve the environment contents and integrate other applications or hardware such as BlackBoard into their virtual environment.

Implications for higher education institutions

3DVW-based e-learning is highly cost-efficient and beneficial for both students and higher education institutions. The costs of developing and maintaining a virtual learning environment as well as implementing a teaching and learning programme are very low in comparison with the traditional education system.

3DVWs provide excellent opportunities for distance learning programmes where the lectures, workshops, meetings, seminars, teamwork, collaboration, and so on could be easily conducted virtually. Therefore, students and educators can attend the environment virtually from various locations across the globe (Ghanbarzadeh and Ghapanchi, 2018). 3DVW-based teaching and learning programmes could contribute to student retention.

By using e-learning systems as alternatives to the paper-based system, institutions can effectively diminish their carbon footprint, as decreasing our carbon footprint is no longer a distant idea.

Implications for educators and course conveners

3DVWs provide collaboration and networking opportunities on a worldwide scale. Educators and instructors use 3DVWs for collaboration and teamwork purposes among students.

Despite all benefits of 3DVW-based learning, due to the entertaining characteristics of the technology, using a virtual learning environment could be distracting for students. For instance, game-like activities and other attractions in the learning environment might distract students from their studies and involve them in role-playing and being entertained.

In traditional classrooms, teachers usually use body language to communicate with students and transfer the concepts based on students' reactions. This is lost in a 3DWV-based classroom. In order to rectify this problem, substantial course material and resources should be provided and made available to students.

The findings could raise awareness of the significance of the purposeful design of the environment and contents. As a multipurpose platform, 3DVWs provide the opportunity for educators and teachers to develop their virtual learning environment and contents based on their applied teaching and learning theories and methodologies in order to deliver lessons to students.

Implications for Research

The authors believe that the current study can be a starting point for future studies focusing on different aspects of the applied technology in education. According to the findings, there are some directions suggested for future research.

There have been some inconsistencies between the findings of the current study and those of previous studies. According to the findings, the relationship between perceived usefulness and use was not confirmed (H2a), which is inconsistent with the TAM and TAM2 models. The relationship between the perceived enjoyment and the use was also not supported in the study (H4a). Similarly, the relationship between visual attractiveness or computer self-efficacy and use also was not supported by this study (H5a and H6a). Furthermore, the impact of system use on student satisfaction was not confirmed (H7a). Future studies can investigate the inconsistent relationships to approve or reject the significance of the relationships in a similar context.

In the current study, only five factors were defined and examined as antecedents of user acceptance and also the positive outcomes of user acceptance of the technology. Future studies are required to investigate from different perspectives the various factors impacting on user acceptance and/or positive outcomes of user acceptance of 3DVW. New research could identify and investigate new variables that are associated with user acceptance of 3DVW in curriculum activities and positive outcomes much more meticulously.

In this study, four new variables were defined: 3DVW engagement, course engagement, graduation outcome, and retention. Future research is expected to examine these factors in different contexts and/or by using different technologies.

The context of the current study was higher education, and the findings may not be generalised to other educational settings. However, the findings can give some informed direction to future researchers who are planning to apply the technology in other educational settings, such as K–12.

One direct step for future study would be to investigate the findings of the current study in the other platforms of 3DVW technology. Future studies can examine the influential factors that affect user acceptance and positive outcomes in different 3DVW platforms.

The current study did not analyse the data based on gender, age group, cultural background diversity, job, and other parameters associated with participants. This study can be further extended to incorporate different cohorts of university students in the experience to validate the scale used in this study by considering these factors mentioned.

Future studies could also explore other aspects of 3DVWs which were not part of the case study, such as the implementation of the technology on virtual reality, augmented reality, and smart devices such as phones and tablets. It is anticipated that the result of applying the technology on other devices may be different than the result of this case study to a large extent. Implementing various educational methods in the teaching program might also contribute to new findings in the field.

Difficulties, Issues and Limitations of Using 3DVWs in Higher Education

Despite the enormous capabilities of 3DVWs for higher education, there are a number of requirements for establishing a virtual distance learning programme, as well as some difficulties of which developers and designers should be aware of. These technologies are highly dependent on computer hardware and without using powerful machines or smart devices (with a proper processor, memory, and graphics) using this technology in an educational system could be problematic. Users need to have high-speed computers to be able to navigate easily in the virtual learning environment. Moreover, as virtual worlds are internet-based technologies, the user needs to connect to a high-speed internet connection. Without an appropriate internet connection, the activities would lag, and the connected users would not be able to act synchronously, which causes significant problems in the learning programme. Additionally, these platforms are in the early stages of their development and have some technical barriers and challenges to overcome. However, it is believed that these issues will be resolved over time, and the value they contribute to the educational community will be worth the current difficulties.

Conclusion

This paper aimed to examine the impacts of different variables on user acceptance of 3DVW technology in higher education. Additionally, this study examined the effect of user acceptance of the technology on student's positive outcomes. A 3DVW-based distance learning virtual environment was designed, developed, and used in a large undergraduate subject. By employing a quantitative method, a research model was developed, and the impact of five independent variables on user acceptance of 3DVW was examined. The study examined the impacts of the use of this technology on five dependent variables relevant to positive outcomes. To evaluate the hypotheses, a survey with 32 questions was designed and distributed among the students, and 135 students participated in the survey. After data collection, a PLS-SEM method utilising SmartPLS 3.0 was used for data analysis. As a result, 11 out of 21 hypotheses were confirmed, and ten were not confirmed in this study. Findings revealed that perceived ease of use, perceived usefulness, perceived enjoyment, and visual attractiveness are the antecedents of acceptance of 3DVWs as a platform for online learning in higher education. Application of the technology also has a significant impact on student satisfaction, learning outcome, retention, course engagement, and graduate outcome of higher education students. The study confirms that computer self-efficacy of higher education students does not have a positive impact on the acceptance of 3DVWs. The use of 3DVW technology without engagement in it will not have a significant impact on the positive outcomes. According to the findings, although 3DVW technology is in the early stages of its development and has some barriers and challenges to overcome, it has the potential to be applied and accepted as a platform for developing distance learning programmes in the higher education sector and will have positive outcomes for students. The study provided a number of implications for the various practitioner and research groups and can be a starting point for future studies.

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REFERENCES

Agrebi, S., & Jallais, J. (2015). Explain the intention to use smartphones for mobile shopping. *Journal of Retailing and Consumer Services*, *22*, 16-23. https://doi.org/10.1016/j.jretconser.2014.09.003

Ahmad, N., & Abdulkarim, H. (2019). The impact of flow experience and personality type on the intention to use virtual world. *International Journal of Human–Computer Interaction*, *35*(12), 1074-1085. https://doi.org/10.1080/10447318.2018.1509500

Al-Emran, M., Mezhuyev, V., & Kamaludin, A. (2020). Towards a conceptual model for examining the impact of knowledge management factors on mobile learning acceptance. *Technology in Society, 61*, 101247. https://doi.org/10.1016/j.techsoc.2020.101247

Alqurashi, E. (2019). Predicting student satisfaction and perceived learning within online learning environments. *Distance Education*, *40*(1), 133-148. https://doi.org/10.1080/01587919.2018.1553562

Alruwath, M. E. (2015). Effect of blended learning on student's satisfaction for students of the public authority for applied education and training in Kuwait. *Ovidius University Annals, Series Physical Education and Sport/Science, Movement and Health, 15*(2 S1), 442-449. https://www.analefefs.ro/anale-fefs/2015/i2s/pe-autori/v2/33.pdf

Anderson, J. C., & Gerbing, D. W. (1988). Structural equation modeling in practice: A review and recommended two-step approach. *Psychological Bulletin, 103*(3), 411. https://doi.org/10.1037/0033-2909.103.3.411

Arbaugh, J. B. (2000). Virtual classroom characteristics and student satisfaction with internet-based MBA courses. *Journal of Management Education*, *24*(1), 32-54. https://doi.org/10.1177/105256290002400104

Arfat, Y., Rahman, C. A., Rahman, M., & Mahmood, K. (2018). Perceived usefulness of e-government and computer self-efficacy to improve continuous intention to use e-government services. *Pakistan Business Review*, *20*(1), 174-183. https://journals.iobmresearch.com/index.php/PBR/article/view/1320/437

Asadi, N., Khodabandeh, F., & Yekta, R. R. (2019). Comparing and contrasting the interactional performance of teachers and students in traditional and virtual classrooms of advanced writing course in distance education university. *Turkish Online Journal of Distance Education*, *20*(4), 135-148. https://doi.org/10.17718/tojde.640552

Astin, A. W. (1993). *What matters in college? Four critical years revisited* (Vol. 1). Jossey-Bass.

Bandura, A. (1986). *Social foundations of thought and action.* Prentice Hall.

Barbosa, T., Lopes, S., Leão, C. P., Soares, F., & Carvalho, V. (2018). Serious game for teaching statistics in higher education: Storyboard design. In A. Brooks, E. Brooks, & C. Sylla C (Eds), *Interactivity, Game Creation, Design, Learning, and Innovation* (pp. 169-175). Springer. https://doi.org/10.1007/978-3-030-06134-0_18

Berge, Z. L., & Huang, Y.-P. (2004). A model for sustainable student retention: A holistic perspective on the student dropout problem with special attention to e-learning. *DEOSNEWS, 13*(5). http://hdl.handle.net/11603/16336

Bhattacherjee, A. (2001). Understanding information systems continuance: An expectation-confirmation model. *MIS Quarterly*, *25*(3), 351-370. https://doi.org/10.2307/3250921

Boulos, M. N. K., Hetherington, L., & Wheeler, S. (2007). Second Life: An overview of the potential of 3-D virtual worlds in medical and health education. *Health Information & Libraries Journal, 24*(4), 233-245. https://doi.org/10.1111/j.1471-1842.2007.00733.x

Chen, X. F., Slau, K., & Nah, F. F.-H. (2008). Adoption of 3-D virtual worlds for education. *ICIS 2008 Proceedings*, 113. https://aisel.aisnet.org/icis2008/113/

Chiu, C. M., Hsu, M. H., Sun, S. Y., Lin, T. C., & Sun, P. C. (2005). Usability, quality, value and e-learning continuance decisions. *Computers & Education*, *45*(4), 399-416. https://doi.org/10.1016/j.compedu.2004.06.001

Compeau, D. R., & Higgins, C. A. (1995). Computer self-efficacy: Development of a measure and initial test. *MIS Quarterly*, *19*(2), 189-211. https://doi.org/10.2307/249688

Connell, J. P., & Wellborn, J. G. (1991). Competence, autonomy, and relatedness: A motivational analysis of self-system processes. In M. R. Gunnar & L. A. Sroufe (Eds.), *The Minnesota symposia on child psychology, Vol. 23. Self processes and development* (p. 43–77). Lawrence Erlbaum Associates. https://psycnet.apa.org/record/1991-97029-002

Davis, F. D. (1985). A technology acceptance model for empirically testing new end-user information systems: Theory and results (Doctoral dissertation, Massachusetts Institute of Technology). https://dspace.mit.edu/bitstream/handle/1721.1/15192/14927137-MIT.pdf

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly, 13*(3), 319-340. https://doi.org/10.2307/249008

Davis, F. D., Bagozzi, R. P., & Warshaw, P. R. (1992). Extrinsic and intrinsic motivation to use computers in the workplace1. *Journal of Applied Social Psychology, 22*(14), 1111-1132. https://doi.org/10.1111/j.1559-1816.1992.tb00945.x

Delone, W. H. (2003). The DeLone and McLean model of information systems success: A ten-year update. *Journal of Management Information Systems, 19*(4), 9-30. https://doi.org/10.1080/07421222.2003.11045748

DeLone, W. H., & McLean, E. R. (1992). Information systems success: The quest for the dependent variable. *Information Systems Research, 3*(1), 60-95. https://doi.org/10.1287/isre.3.1.60

Deng, R., Benckendorff, P., & Gannaway, D. (2020). Learner engagement in MOOCs: Scale development and validation. *British Journal of Educational Technology*, *51*(1), 245-262. https://doi.org/10.1111/bjet.12810

DeVilbiss, S. E. (2014). The transition experience: *Understanding the transition from high school to college for conditionally-admitted students using the lens of Schlossberg's transition theory* (Doctoral dissertation, University of Nebraska, Lindoln). https://digitalcommons.unl.edu/cehsedaddiss/187/

Elfeky, A. I. M., & Elbyaly, M. Y. H. (2018). Developing skills of fashion design by augmented reality technology in higher education. *Interactive Learning Environments, 1-16.* https://doi.org/10.1080/10494820.2018.1558259

Estriegana, R., Medina-Merodio, J. A., & Barchino, R. (2019). Student acceptance of virtual laboratory and practical work: An extension of the technology acceptance model. *Computers & Education*, *135*, 1-14. https://doi.org/10.1016/j.compedu.2019.02.010

Ewais, A., Awad, M., & Hadia, K. (2020). Aligning learning materials and assessment with course learning outcomes in MOOCs using data mining techniques. In I. Hatzilygeroudis, I. Perikos, & F. Grivokostopoulou (Eds), *Advances in integrations of intelligent methods* (pp. 1-25). Springer. https://doi.org/10.1007/978-981-15-1918-5_1

Fishbein, M. (1979). A theory of reasoned action: some applications and implications. *Nebraska Symposium on Motivation, 27*, 65–116.

Franklin, T. J. (2011). The mobile school: Digital communities created by mobile learners. In G. Wan, & D. M. Gut (Eds), *Bringing schools into the 21st century* (pp. 187-203). Springer. https://doi.org/10.1007/978-94-007-0268-4_9

Gallego, M. D., Bueno, S., & Noyes, J. (2016). Second Life adoption in education: A motivational model based on Uses and Gratifications theory. *Computers & Education*, *100*, 81-93. https://doi.org/10.1016/j.compedu.2016.05.001

Ghanbarzadeh, R. (2017). *Investigating antecedents and consequences of user acceptance of three-dimensional virtual worlds* (Doctoral thesis, Griffith University, Queensland, Australia).

Ghanbarzadeh, R., & Ghapanchi, A. H. (2018). Investigating various application areas of three-dimensional virtual worlds for higher education. *British Journal of Educational Technology, 49*(3), 370-384. https://doi.org/10.1111/bjet.12538

Ghanbarzadeh, R., & Ghapanchi, A. H. (2020). Uncovering educational outcomes deriving from students' acceptance and involvement with 3D virtual worlds. *Education and Information Technologies*, 1-27. https://doi.org/10.1007/s10639-020-10272-7

Guthrie, J. T., & Anderson, E. (1999). Engagement in reading: Processes of motivated, strategic, knowledgeable, social readers. In J. T. Guthrie & E. Anderson (Eds.), *Engaged reading: Processes, practices, and policy implications* (pp. 17-45). Teachers College Press. https://catalyst.library.jhu.edu/catalog/bib_2121060

Hew, K. F. (2015). Towards a model of engaging online students: Lessons from MOOCs and four policy documents. *International Journal of Information and Education Technology, 5*(6), 425. https://doi.org/10.7763/ijiet.2015.v5.543

Hew, K. F., Hu, X., Qiao, C., & Tang, Y. (2020). What predicts student satisfaction with MOOCs: A gradient boosting trees supervised machine learning and sentiment analysis approach. *Computers & Education*, *145*, 103724. https://doi.org/10.1016/j.compedu.2019.103724

Hiltz, S. R. (1988, January). Collaborative learning in a virtual classroom: Highlights of findings. In *Proceedings of the 1988 ACM conference on Computer-supported cooperative work* (pp. 282-290). https://doi.org/10.1145/62266.62289

Hodgson, P., Lee, V. W., Chan, J. C., Fong, A., Tang, C. S., Chan, L., & Wong, C. (2019). Immersive virtual reality (IVR) in higher education: Development and implementation. In M. C. tom Dieck & T. Jung (Eds.), *Augmented reality and virtual reality* (pp. 161-173). Springer. https://doi.org/10.1007/978-3-030-06246-0_12

Holsapple, C. W., & Lee-Post, A. (2006). Defining, assessing, and promoting e-learning success: An information systems perspective. *Decision Sciences Journal of Innovative Education, 4*(1), 67-85. https://doi.org/10.1111/j.1540-4609.2006.00102.x

Hsu, C. L., & Lin, J. C. C. (2018). Exploring factors affecting the adoption of internet of things services. *Journal of Computer Information Systems*, *58*(1), 49-57. https://doi.org/10.1080/08874417.2016.1186524

Joo, Y. J., So, H. J., & Kim, N. H. (2018). Examination of relationships among students' self-determination, technology acceptance, satisfaction, and continuance intention to use K-MOOCs. *Computers & Education*, *122*, 260-272. https://doi.org/10.1016/j.compedu.2018.01.003

Karahanna, E., Agarwal, R., & Angst, C. M. (2006). Reconceptualizing compatibility beliefs in technology acceptance research. *MIS Quarterly, 30*(4), 781-804. https://doi.org/10.2307/25148754

Kim, C., Lee, S. G., & Kang, M. (2012). I became an attractive person in the virtual world: Users' identification with virtual communities and avatars. *Computers in Human Behavior*, *28*(5), 1663-1669. https://doi.org/10.1016/j.chb.2012.04.004

Koufaris, M. (2002). Applying the technology acceptance model and flow theory to online consumer behavior. *Information Systems Research, 13*(2), 205-223. https://doi.org/10.1287/isre.13.2.205.83

Lee, J., Kim, J., & Choi, J. Y. (2019). The adoption of virtual reality devices: The technology acceptance model integrating enjoyment, social interaction, and strength of the social ties. *Telematics and Informatics*, *39*, 37-48. https://doi.org/10.1016/j.tele.2018.12.006

Lee, M.-C. (2010). Explaining and predicting users' continuance intention toward e-learning: An extension of the expectation–confirmation model. *Computers & Education, 54*(2), 506-516. https://doi.org/10.1016/j.compedu.2009.09.002

Lew, S. L., Lau, S. H., & Leow, M. C. (2019). Usability factors predicting continuance of intention to use cloud e-learning application. *Heliyon*, *5*(6), e01788. https://doi.org/10.1016/j.heliyon.2019.e01788

Linden Lab. (2013). *Infographic: Ten years of Second Life*. http://www.lindenlab.com/releases/infographic-10-years-of-second-life

Linganisa, A., Ako-Nai, A., & Ajayi, N. (2018, December). The potential of Second Life as a platform for learning: Student's perspective. In *2018 International Conference on Intelligent and Innovative Computing Applications (ICONIC)* (pp. 1-5). IEEE. https://doi.org/10.1109/ICONIC.2018.8601201

Liu, W. (2014). Explaining and predicting older adult' continuance intention toward SNSs: An extension of the expectation–confirmation model. *Lecture Notes on Information Theory*, *2*(3), 254-258. https://doi.org/10.12720/lnit.2.3.254-258

Lorenzo-Alvarez, R., Rudolphi-Solero, T., Ruiz-Gomez, M. J., & Sendra-Portero, F. (2020). Game-based learning in virtual worlds: A multiuser online game for medical undergraduate radiology education within Second Life. *Anatomical Sciences Education*, *13*(5), 602-617. https://doi.org/10.1002/ase.1927

Masters, Y., & Gregory, S. (2010). *Second Life: Harnessing virtual world technology to enhance student engagement and learning.* Paper presented at the Rethinking learning in your discipline. Proceedings of the University Learning and Teaching Futures Colloquium. https://www.semanticscholar.org/paper/Second-Life%3A-Harnessing-Virtual-World-Technology-to-Masters-Gregory/1832ac6ec3d136655e1c141b6ff2d6595b633b2d

Matell, M. S., & Jacoby, J. (1971). Is there an optimal number of alternatives for Likert scale items? Study I: Reliability and validity. *Educational and Psychological Measurement, 31*, 657-674. https://doi.org/10.1177/001316447103100307

Mathwick, C., Malhotra, N., & Rigdon, E. (2001). Experiential value: Conceptualization, measurement and application in the catalog and Internet shopping environment. *Journal of Retailing*, *77*(1), 39-56. https://doi.org/10.1016/S0022-4359(00)00045-2

Mensah, I. K., & Mi, J. (2019). Computer self-efficacy and e-government service adoption: The moderating role of age as a demographic factor. *International Journal of Public Administration*, *42*(2), 158-167. https://doi.org/10.1080/01900692.2017.1405980

Merchant, Z., Keeney-Kennicutt, W., & Goetz, E. (2015). Predicting undergraduate students' acceptance of Second Life for teaching chemistry. *Journal of Online Learning & Teaching*, *11*(2). https://www.semanticscholar.org/paper/Predicting-Undergraduate-Students%27-Acceptance-of-Merchant-Keeney-Kennicutt/0b280fae7c82e8fff5f0bc029404f19c4fd8b832?p2df

Moon, J. W., & Kim, Y. G. (2001). Extending the TAM for a World-Wide-Web context. *Information & Management*, *38*(4), 217-230. https://doi.org/10.1016/s0378-7206(00)00061-6

Mosenthal, P. B. (1999). Understanding engagement: Historical and political contexts. In J. T. Guthrie & E. Anderson (Eds.). *Engaged reading: Processes, practices, and policy implications* (pp. 1-16). Teachers College Press. https://catalyst.library.jhu.edu/catalog/bib_2121060

Mostafa, R. B. (2019). Does social media website really matter in enhancing student's retention intention? An application of Stimulus-Organism-Response framework. *International Journal of Management in Education*, *13*(4), 397-416. https://doi.org/10.1504/IJMIE.2019.102603

Mun, Y. Y., & Hwang, Y. (2003). Predicting the use of web-based information systems: Self-efficacy, enjoyment, learning goal orientation, and the technology acceptance model. *International Journal of Human-Computer Studies, 59*(4), 431-449. https://doi.org/10.1016/S1071-5819(03)00114-9

Norton, A., Cherastidtham, I., & Mackey, W. (2018). *Mapping Australian higher education 2018*. Grattan Institute. https://grattan.edu.au/report/mapping-australian-higher-education-2018/

Novak, D., Zaharia, S. E., Pavlinović, M., & Romanović, R. (2019, January). Recognition of prior learning based on competence-based training in aviation sector. In *ZIRP 2019-International Scientific Conference, Science and Traffic Development.*

Oliver, R. L. (1997). *Satisfaction: A behavioral perspective on the consumer.* Irwin-McGraw-Hill.

Oum, S., & Han, D. (2011). An empirical study of the determinants of the intention to participate in user-created contents (UCC) services. *Expert Systems with Applications*, *38*(12), 15110-15121. https://doi.org/10.1016/j.eswa.2011.05.098

Panigrahi, R., Srivastava, P. R., & Sharma, D. (2018). Online learning: Adoption, continuance, and learning outcome—A review of literature. *International Journal of Information Management*, *43*, 1-14. https://doi.org/10.1016/j.ijinfomgt.2018.05.005

Park, E. (2020). User acceptance of smart wearable devices: An expectation-confirmation model approach. *Telematics and Informatics*, *47*, 101318. https://doi.org/10.1016/j.tele.2019.101318

Pellas, N. (2014). The influence of computer self-efficacy, metacognitive self-regulation and self-esteem on student engagement in online learning programs: Evidence from the virtual world of Second Life. *Computers in Human Behavior, 35*, 157-170. https://doi.org/10.1016/j.chb.2014.02.048

Pellas, N., & Kazanidis, I. (2014a). Engaging students in blended and online collaborative courses at university level through Second Life: Comparative perspectives and instructional affordances. *New Review of Hypermedia and Multimedia, 20*(2), 123-144. https://doi.org/10.1080/13614568.2013.856958

Pellas, N., & Kazanidis, I. (2014b). The impact of computer self-efficacy, situational interest and academic self-concept in virtual communities of inquiry during the distance learning procedures through Second Life. *World Wide Web, 17*(4), 695-722. https://doi.org/10.1007/s11280-013-0266-9

Pellas, N., & Kazanidis, I. (2014c). Online and hybrid university-level courses with the utilization of Second Life: Investigating the factors that predict student choice in Second Life supported online and hybrid university-level courses. *Computers in Human Behavior, 40*, 31-43. https://doi.org/10.1016/j.chb.2014.07.047

Pellas, N., & Kazanidis, I. (2015). On the value of Second Life for students' engagement in blended and online courses: A comparative study from the Higher Education in Greece. *Education and Information Technologies*, *20*(3), 445-466. https://doi.org/10.1007/s10639-013-9294-4

Pham, L., Limbu, Y. B., Bui, T. K., Nguyen, H. T., & Pham, H. T. (2019). Does e-learning service quality influence e-learning student satisfaction and loyalty? Evidence from Vietnam. *International Journal of Educational Technology in Higher Education*, *16*(1), 7. https://doi.org/10.1186/s41239-019-0136-3

Ringle, C. M., Wende, S., & Becker, J.-M. (2015). *SmartPLS 3*. Bönningstedt: SmartPLS. Retrieved from http://www.smartpls.com

Saadé, R. G., He, X., & Kira, D. (2007). Exploring dimensions to online learning. *Computers in Human Behavior, 23*(4), 1721-1739. https://doi.org/10.1016/j.chb.2005.10.002

Saba, T. (2012). Implications of E-learning systems and self-efficiency on students outcomes: A model approach. *Human-centric Computing and Information Sciences, 2*(1), 1-11. https://doi.org/10.1186/2192-1962-2-6

Schuetz, P. (2008). Developing a theory-driven model of community college student engagement. *New Directions for Community Colleges, 2008*(144), 17-28. https://doi.org/10.1002/cc.342

Selzer, M. N., Gazcon, N. F., & Larrea, M. L. (2019). Effects of virtual presence and learning outcome using low-end virtual reality systems. *Displays*, *59*, 9-15. https://doi.org/10.1016/j.displa.2019.04.002

Shen, J., & Eder, L. B. (2009). Intentions to use virtual worlds for education. *Journal of Information Systems Education*, *20*(2), 225. https://jise.org/volume20/n2/JISEv20n2p225.html

Shiau, W. L., & Chau, P. Y. (2016). Understanding behavioral intention to use a cloud computing classroom: A multiple model comparison approach. *Information & Management*, *53*(3), 355-365. https://doi.org/10.1016/j.im.2015.10.004

Sirakaya, M., & Cakmak, E. K. (2018). The effect of augmented reality use on achievement, misconception and course engagement. *Contemporary Educational Technology*, *9*(3), 297-314. https://doi.org/10.30935/cet.444119

Skinner, E. A., Kindermann, T. A., & Furrer, C. J. (2009). A motivational perspective on engagement and disaffection: Conceptualization and assessment of children's behavioral and emotional participation in academic activities in the classroom. *Educational and Psychological Measurement*, *69*(3), 493-525. https://doi.org/10.1177/0013164408323233

Stuntz, T. (2020). *Self-regulated learning in distance education course design: Student perceptions of embedded strategies* (Doctoral dissertation, California State University, Fresno). https://search.proquest.com/openview/2f7257527130433b7a5479e01fb47c1a/1?pq-origsite=gscholar&cbl=18750&diss=y

Sun, J. C.-Y., Martinez, B., & Seli, H. (2014). Just-in-time or plenty-of-time teaching? Different electronic feedback devices and their effect on student engagement. *Educational Technology & Society, 17*(2), 234-244. https://www.jstor.org/stable/pdf/jeductechsoci.17.2.234.pdf

Tahar, A., Riyadh, H. A., Sofyani, H., & Purnomo, W. E. (2020). Perceived ease of use, perceived usefulness, perceived security and intention to use e-filing: The role of technology readiness. *The Journal of Asian Finance, Economics, and Business*, *7*(9), 537-547. https://doi.org/10.13106/jafeb.2020.vol7.no9.537

Van der Heijden, H. (2003). Factors influencing the usage of websites: The case of a generic portal in The Netherlands. *Information & Management, 40*(6), 541-549. https://doi.org/10.1016/S0378-7206(02)00079-4

Van der Heijden, H. (2004). User acceptance of hedonic information systems. *MIS Quarterly, 28*(4), 695-704. https://doi.org/10.2307/25148660

Venkatesh, V., Brown, S. A., Maruping, L. M., & Bala, H. (2008). Predicting different conceptualizations of system use: The competing roles of behavioral intention, facilitating conditions, and behavioral expectation. *MIS Quarterly, 32*(3), 483-502. https://doi.org/10.2307/25148853

Venkatesh, V., & Davis, F. D. (2000). A theoretical extension of the technology acceptance model: Four longitudinal field studies. *Management science, 46*(2), 186-204. https://doi.org/10.1287/mnsc.46.2.186.11926

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *MIS quarterly*, 425-478. https://doi.org/10.2307/30036540

Venkatesh, V., Morris, M. G., Sykes, T. A., & Ackerman, P. L. (2004). Individual reactions to new technologies in the workplace: The role of gender as a psychological construct. *Journal of Applied Social Psychology*, *34*(3), 445-467. https://doi.org/10.1111/j.1559-1816.2004.tb02556.x

Verhagen, T., Feldberg, F., Van Den Hooff, B., & Meents, S. (2009). *Understanding virtual world usage: A multipurpose model and empirical testing.* Paper presented at the ECIS.

Villano, R., Harrison, S., Lynch, G., & Chen, G. (2018). Linking early alert systems and student retention: A survival analysis approach. *Higher Education*, *76*(5), 903-920. https://doi.org/10.1007/s10734-018-0249-y

Vrellis, I., Avouris, N., & Mikropoulos, T. A. (2016). Learning outcome, presence and satisfaction from a science activity in Second Life. *Australasian Journal of Educational Technology*, *32*(1). https://doi.org/10.14742/ajet.2164

Webster, J., & Ho, H. (1997). Audience engagement in multimedia presentations. *ACM SIGMIS Database: The DATABASE for Advances in Information Systems*, *28*(2), 63-77. https://doi.org/10.1145/264701.264706

Willicks, F., Stehling, V., Richert, A., & Isenhardt, I. (2018, April). The students' perspective on mixed reality in higher education: A status and requirement analysis. In *2018 IEEE Global Engineering Education Conference (EDUCON)* (pp. 656-660). IEEE. https://doi.org/10.1109/EDUCON.2018.8363293

Wu, B., & Zhang, C. (2014). Empirical study on continuance intentions towards E-Learning 2.0 systems. *Behaviour & Information Technology, 33*(10), 1027-1038. https://doi.org/10.1080/0144929X.2014.934291

Wu, J. H., & Wang, Y. M. (2006). Measuring KMS success: A respecification of the DeLone and McLean's model. *Information & Management*, *43*(6), 728-739. https://doi.org/10.1016/j.im.2006.05.002

Wu, S. T., Chiu, C. H., & Chen, Y. S. (2020). The influences of innovative technological introduction on interpretive experiences of exhibition: A discussion on the intention to use augmented reality. *Asia Pacific Journal of Tourism Research*, *25*(6), 652-667. https://doi.org/10.1080/10941665.2020.1752754

Yang, H.-H. (2007). *The effect of technology acceptance on undergraduate students' usage of Webct as a collaborative tool* (Doctoral theses, University of Central Florida). https://stars.library.ucf.edu/etd/3419/

Yang, H., Yu, J., Zo, H., & Choi, M. (2016). User acceptance of wearable devices: An extended perspective of perceived value. *Telematics and Informatics*, *33*(2), 256-269. https://doi.org/10.1016/j.tele.2015.08.007

Yilmaz, R. (2017). Exploring the role of e-learning readiness on student satisfaction and motivation in flipped classroom. *Computers in Human Behavior*, *70*, 251-260. https://doi.org/10.1016/j.chb.2016.12.085

Zhoc, K. C., Webster, B. J., King, R. B., Li, J. C., & Chung, T. S. (2019). Higher education student engagement scale (HESES): Development and psychometric evidence. *Research in Higher Education*, *60*(2), 219-244. https://doi.org/10.1007/s11162-018-9510-6

APPENDIX. THE INSTRUMENT USED IN THE STUDY

The following table shows the constructs, questionnaire's questions, and references for each question.

Construct	Questions	Reference (Adapted from)
Perceived Ease of Use	1. Learning to work with Second Life was easy for me.	Davis (1989)
	2. It was easy for me to become skilful at using Second Life.	Davis (1989)
	3. Overall, Second Life was easy to use.	Davis (1989)
Perceived Usefulness	4. Using Second Life for my course improved my learning performance.	Davis (1989)
	5. Using Second Life for my course enhanced my learning effectiveness.	Davis (1989)
	6. I found Second Life to be useful to my learning.	Davis (1989)
Perceived Enjoyment	7. Using Second Life for education is pleasurable.	M.-C. Lee (2010); Moon and Kim (2001)
	8. I had fun using Second Life in my course.	M.-C. Lee (2010); Moon and Kim (2001))
	9. I found using Second Life in education to be interesting.	M.-C. Lee (2010); Moon and Kim (2001)
Visual Attractiveness	10. The way things are displayed in Second Life are attractive.	Van der Heijden (2003); Mathwick et al. (2001)
	11. The virtual lands are aesthetically appealing.	Van der Heijden (2003); Mathwick et al. (2001)
	12. Overall, I find that the virtual lands look attractive.	Van der Heijden (2003); Mathwick et al. (2001)
Computer Self-Efficacy	13. I could work with a software package if there was no one around to tell me what to do as I go.	Shen and Eder (2009)
	14. I could work with a software package if I had never used a package like it before.	Shen and Eder (2009)
	15. I could work with a software package if I had seen someone else using it before trying it myself.	Shen and Eder (2009)
Use	16. I used Second Life several times.	Venkatesh et al. (2008)
	17. I have spent several hours using Second Life.	Venkatesh et al. (2008)
3DVW Engagement	18. Second Life holds my attention	Webster and Ho (1997)
	19. This immersive medium excited my curiosity.	Webster and Ho (1997)
	20. Overall, Second Life is an engaging technology.	Webster and Ho (1997)
Student Satisfaction	21. Overall, I am satisfied with Second Life.	Chiu et al., (2005); J. H. Wu and Wang (2006)
	22. Overall, I am satisfied with the learning experience in this course.	Arbaugh (2000)
Learning Outcome	23. I learned about the critical issues related to the course topics.	Hiltz (1988)
	24. I identified the important subject matter related to the course topics.	Hiltz (1988)
	25. My understanding about the important course topics has increased.	Hiltz (1988)
Student Retention	26. If I could, I would like to continue using Second Life in my learning activities in the future.	Bhattacherjee (2001); Kim et al. (2012)
	27. I will strongly recommend that others use Second Life.	Bhattacherjee (2001); Liu (2014)
Course Engagement	28. I believe that this course engaged me in learning.	Self-Developed
	29. I liked participating actively in various parts of this course.	Self-Developed

Graduate Outcome	30. I believe that the course content can be applied in my future career.	Self-Developed
	31. I believe that this course helped me to learn a skill to enhance my future business.	Self-Developed
	32. The knowledge learned through this course can be useful in real life.	Self-Developed

BIOGRAPHIES

Dr Reza Ghanbarzadeh is currently an academic at the School of Business and Tourism, Southern Cross University, Australia. Reza obtained his PhD in the field of information systems from Griffith University, Australia. He holds a master's and a bachelor's degrees in software engineering. His research mainly focuses on human-computer interaction, user experience, software engineering, and the innovative use of technologies in various contexts, and he has published several peer-reviewed publications in these fields.

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