CAN VIRTUAL REALITY HAVE A POSITIVE INFLUENCE ON STUDENT ENGAGEMENT?

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ABSTRACT

Through the rapid development of virtual reality (VR), South African Higher Educational Institutions (HEIs) have shown interest in the potential VR has in teaching and learning practices. HEIs are further urged by the South African government to use cutting edge educational technology (edtech) tools to promote student engagement and limit the high dropout rates noticeable in HEIs. The researcher explored the perceived impact VR can have on student engagement.

A qualitative research methodology was adopted for this study and the research instruments included open-ended questionnaires, semi-structured interviews, and a true experiment. Thirty-six participants took part in the study.

The results of the study highlight a 23 per cent higher pass rate and a 180 per cent higher engagement level in students using VR as opposed to students studying via online distance learning. Two themes emerged from the results, namely: (1) the use of VR in teaching and learning, and (2) the influence VR has on student engagement levels.

The results of this study further highlight that VR learning yields higher student engagement levels and as a result, students achieve higher marks. The significance of the study lies in the assistance it can offer higher educational institutions in their decision-making process of adopting VR into their teaching and learning processes.

Keywords: distance learning online, virtual reality learning, Edtech, student engagement

INTRODUCTION

South Africa is at the tipping point of having to adapt a new teaching philosophy. The National Development Plan for South Africa's vision for 2030 places significant emphasis on high-quality education in higher education institutions (National Planning Commission 2022, 300)

and describes the challenges faced by the educational environment.

Challenges such as policies to widen access to higher education has led to an influx of students and as a result, Higher Education Institutions (HEIs) have been witness to the increasing number of dropout rates and poor overall pass rates (Meyer 2014, 7). The South African Minister of Higher Education, Blade Nzimande, raised his concerned about the high dropout rate and low pass rate among students. It has been found that between 50 per cent and 60 per cent of students will drop out during their first year of studies (Dyomfana 2022, 1). HEIs are further criticized for their low throughput rates and poor results (Meyer 2014, 7). Making education relevant in the 21st century is a complex and important pursuit. Therefore, HEIs will undoubtedly have to play an exceptional role in andragogy and student engagement (National Planning Commission 2022, 300).

The first theme arising from this study is *student engagement*. Realising that student engagement is crucial to the academic success of a student makes this study relevant in a time where HEIs experience high dropout rates. As South African HEIs are increasingly urged by government to improve their quality of teaching and learning, the importance of student engagement and the unique role it plays in the student's learning journey need to be investigated. Students "experience" and therefore "engage" differently to the world than their parents did several years ago (Parsons and Taylor 2011, 6).

The second theme arising from the study is *the use of virtual reality (VR) in teaching and learning*. The Council of Higher Education (CHE 2018, 12) confirms that although computers and information technology have become ubiquitous, matters such as infrastructure, institutional policy development and practitioner understanding limit the potential for educational change. By leveraging VR, it is possible to address the much-needed skillset of the 21st century, which includes theocratical thinking, reasoning, creativity, problem solving, collaboration, communication, and global citizenship. Moreover, VR learning equips students with skills to engage with digital technology emerging from the Fourth Industrial Revolution (4IR) where digitisation has created smart offices (Meyer 2017). Several studies confirm that students using VR are more engaged in their studies. Compared to other teaching modes, VR learning promises to students' recall of knowledge to be more enhanced, their motivation and interest levels to rise, their understanding of the subject area to increases, and most importantly, their achievement to be higher when learning with VR (Wickens 1992, 842–847; Aczel 2017, 6–22; Alqahtani, Daghestani, and Ibrahim 2017, 2; Savickaite, McDonnell and Simmons 2022, 2; Schoenlein et al. 2020, 1; Sakaki et al. 2021, 1; Richter et al. 2022, 1; Papanastasiou et al. 2019, 425–436; Vasarainen, Paavola and Vetoshkina 2021, 2).

The critical argument in this article is that VR should be used in teaching and learning to

improve student engagement, which then increases student success. This article presents the aggregate views of lecturers, students, and VR experts. Through a qualitative research approach, the article presents data extrapolated from an open-ended questionnaire, a semi-structured interview, and a true experiment, making use of a random post-test control group design.

LITERATURE REVIEW

Student engagement

It is a common phenomenon that educational institutions seek to promote student engagement. A current imperative in HEIs is to ensure that throughput (achievement) rates are well received by the South African Department of Higher Education and Training (2019). Theorists have identified that healthy student engagement affects student achievement positively (Bowden and Naumann 2021, 1207–1224; Aczel 2017, 11; Alqahtani et al. 2017, 2; Savickaite et al. 2022, 2; Schoenlein et al. 2020, 1; Sakaki et al. 2021, 1; Richter et al. 2022, 1; Papanastasiou et al. 2019, 427; Kahu and Lodge 2018, 1; Bowden and Naumann 2021, 1211; Singh et al. 2019, 300–302).

The notion of student engagement in higher education has emerged over the past decade as a reliable predictor of students' academic success (Schreiber and Yu 2016, 157–175). Bowden and Naumann (2021, 1210) allude to the fact that as HEIs begin to measure the level of student engagement, "it offers the ability to quality and monitor the extent to which a student's baseline expectations are being met by the institution". Therefore, student engagement is a useful framework to assist HEIs in examining students' academic success (Schreiber and Yu 2016, 157–160).

Interestingly, the challenge of increasing student engagement is not unique to South-Africa. Challenges such as high student dropout rates and poor pass results are shared among many other international HEIs. The South African Survey of Student Engagement (SASSE) (Strydom and Mentz 2010, 4) compared the challenges facing Higher Education in the United States and South Africa. The outcome of the SASSE study is presented in the table below.

Table 1: Challenges facing HEIs

Challenges facing Higher Education Institutions	
Internationally	**South Africa**
Low pass rates.	Very low pass rates (around 15% of students graduate in time).
Low enrolment of minority group students.	Participation rates of previously excluded Black African students are around 12%.
Low pass rates among low income, minority group students.	One in three Black African students graduate in time, less than 5% of this cohort obtains a degree.

Challenges facing Higher Education Institutions	
Internationally	**South Africa**
Students are not adequately prepared in high school.	Students are not adequately prepared in high school.
Increased demand for graduates in the knowledge economy results in a rapidly expanding student body with unprecedented levels of diversity and large numbers of first generations students.	Widening access and an increased demand for graduates in the knowledge economy have led to unprecedented levels of diversity and many first-generation students.
Development of online learning.	Implementation of online learning during COVID-19.
Sustainability of current edtech trends.	Increase in the adoption of internet-related technologies/edtech.
Social acceptability of higher fees. Climate change and sustainability.	Cost of learning fees/Fees must fall.

(Source: Strydom and Mentz 2010, 7; Dameron and Durand 2017, 3)

From Table 1 it is evident that HEIs worldwide encounter similar challenges to that in South Africa. Challenges include low pass rates, low student enrolment, poor preparedness for tertiary education, the implementation and adoption of online learning and educational technology, and finally, the cost of learning.

Given the perplexed state that HEIs find themselves in, it would be crucial for educational institutions to examine the profound role virtual reality can play in teaching and learning to increase student engagement. HEIs are continuously averting to the latest trends in education while ensuring that the job market requirements are in line with the latest technological advancements (Kuleto et al. 2021, 4).

Notably, students can engage in adopting one of two perspectives, namely by demonstrating either constructivist or behaviouralist characteristics (Moosa 2019, 88). From a constructivist student engagement perspective, learning is influenced by how students participate in teaching and learning activities. With constructivism, the student creates meaning from the learning that took place (Ertmer and Newby 2013, 43–45). From the behaviouralist student engagement perspective, students are concerned with learning satisfaction and achievement when spending time on tasks or collaborating with the lecturer and other students. Through behaviourism, learning is explained or illustrated and thereafter applied (Moosa 2019, 89; Ertmer and Newby 2013, 43–45).

It is important to note that any form of engagement, also when utilising VR, can be considered a communicative experience as communication allows for the sharing of emotions, thoughts, and knowledge. In the context of VR, communicative engagement refers to the degree to which students are involved in the learning process and how connected they feel towards the learning process. To promote communicative engagement, it is imperative to consider how the online VR content will be delivered (Kharouf et al. 2020, 735). A further factor to consider in the promotion of communicative engagement is the effectiveness of the instructional design to leverage VR communicative engagement. A practical example would be to allow students to

create customizable avatars with the ability to communicate with other avatars in an immersive environment (Zhao and McClure 2022, 3).

The interrelationship between digital engagement, which can be constructive or behavioural, requires communication (Tong and Chan 2023, 1). In a traditional face-to-face environment, students use verbal cues to act on, whereas in a VR learning environment, the use of non-verbal cues are more effective.

HEIs should take note of both the constructivist and the behavioural student engagement perspectives in order to adopt a balanced and comprehensive approach to teaching and learning. By adopting a holistic approach to learning, student engagement will be increased.

This article further investigates the importance of using VR to increase student engagement.

Virtual reality

For modern HEIs to thrive and keep students engage, it is important to have foresight and imagine how the future of education will look like, and most importantly, how students will be kept engaged. From storytelling to modern technology, developers have tried to capture their audiences (in this case, the students) by making them feel present in an alternate reality that is created (Sherman and Craig 2019, 4–5). A few years ago, virtual reality was used only by a selected few; it was deemed far too futuristic to be used in education. Lately, the use of VR is dramatically evolving in the educational field, becoming a preferable learning tool. Virtual reality provides exciting avenues for students to engage in.

The conceptual definition of VR has been challenged since the adoption of immersive VR as a pedagogical tool in teaching and learning environments (Hamilton et al. 2021, 2). Virtual reality is defined as a tool for immersive learning, which means it is a resource that can take individuals to an interactive learning environment with 360-degree views, physically or virtually (Uptale 2019; Savickaite et al. 2022, 1; Hamilton et al. 2021, 2).

One of the main advantages of virtual reality in teaching and learning is that students can study in their *own space and time,* as they do not have to be in class physically. Though VR, a lesson can be repeated and a student can pause an experience (Pirker 2017, 48; Papanastasiou et al. 2019, 426). VR experiences are created to *mimic the real world* whereby students can touch, feel, and experience certain learning objects and even visit places (ClassVR 2018, 1). Students' *social experiences* can enhance as they "travel" in virtual reality. Visiting places without being there physically is now possible through VR. As a result, global barriers are broken down whilst students get the opportunity to learn *foreign languages* to communicate with other students in the virtual world (Engels 2017, 1). VR software is available to switch the

tuition language between different languages, thus making learning possible in any language (Hicks 2016, 1).

Furthermore, the learning experience created though VR cannot be duplicated in a textbook, online video or pictures, which are often related to correspondence or distance learning online courses. In VR, *learning is stimulated by "doing"* (the student can practically engage with the learning object) and therefore a 75 per cent to 90 per cent knowledge retention is obtained versus the 5 per cent to 10 per cent non-virtual reality or traditional classroom retention (Uptale 2019, 1). By using virtual reality, a person can feel and experience what is happening around them (Modi, Jaiswal, and Jain 2016, 911–913), as a "real environment" is simulated to the user. Barron (2006, 58) points out that through VR, *simulations are created* with the purpose of stimulating the user, thus increasing engagement with the student. VR therefore *improves the sensory stimulus* of students and ensures a high attention rate (Uptale 2019, 1). Aczel (2017, 6) concurs and points out that VR further creates a stimulating environment where students can observe, participate, and create. It also assists students to take a *complex object and break open* the layers of the object to gain insight into and experience through multisensory interactions. Within the VR environment, students can *create avatars* when meeting with other users. Literature confirms that by making use of an avatar, a student can be *engaged five times more* than with traditional learning (Gregory et al. 2016, 88). Using a self-avatar, a student enters an immersive environment where they can interact with others (Steed et al. 2016, 67). In addition, the repetition of certain actions *feels safe for the user* and allows failing attempts without any physical damage to the user (Aczel 2017, 6).

To conclude discussing the benefits of VR, it is reassuring to recognise that through VR learning, enhanced access and inclusivity is possible as any geographical and physical barriers can be crossed (Jeffs 2009, 253–268; Pappas 2023, 1). To further promote a democratic student experience, VR has the ability to expose students to diverse perspectives and different cultures through immersed learning experiences.

Contrary to the many positive features of VR, Barron (2006, 4) cautions that integrating technology into teaching and learning can be a *frustrating, time-consuming, challenging, and an expensive exercise.* One of the main reasons for the poor adoption of virtual reality is the lack of virtual reality *learning content* (learning material and assessments) as it is extremely expensive to develop at first. To create, VR simulation is further time-consuming, thus adding to the development costs (Carvalho 2014, 538).

A further disadvantage of the use of VR is the *speed of updates* that needs to be taken into consideration. Due to virtual reality being a relatively new concept in education, there will be several updates the user will have to run frequently. Regular updates require the VR software

to work optimally. Without regular updates, there will not be a seamless operation of the programme, and this can frustrate both students and lecturers. If students experience a disruption in their studies, students lose interest (Hicks 2016, 2).

ClassVR (2018) further cautions lecturers that the *emotional wellbeing* of students need to be carefully monitored, as VR could have a negative effect on students' *vision* caused by the harmful sensory manipulation from the impulses. Side effects such as *dizziness and nausea* have been reported. Some motion sickness problems were also experienced by students, as reported in a study conducted by Checa and Bustillo (2019, 151). This is due to the stimuli received by the eyes, which are different from the stimuli received by the inner ear. Industry experts are working to reduce the motion sickness by investigating how additional brain-machine interface sensors can be used in the VR headset. Through this investigation, the goal is to detect when a user experiences motion sickness. As part of the study, Checa and Bustillo (2019, 151) further found that although VR provides students with the opportunity to learn with freedom and flexibility, this freedom can also mean that students miss out on important parts of the learning experience.

A further disadvantage of using VR in teaching and learning is that if the student is not well-accustomed with the technology, *navigating* the virtual reality platform may be difficult, especially when the student have not received training in navigating the VR platform. As with many edtech software applications, things can go wrong during a student's learning activity, and this can become frustrating and inconvenient for the student (Hicks 2016, 1).

Virtual reality further can reduce *physical connection* with other humans (Pennington 2022, 1) as the users with VR headsets are fully immersed in the VR scenes. No connections with other users are practiced notwithstanding the latest developments to increase social interaction in VR by having special meetings. Maslow (1954) considers social interaction an important aspect of psychological development as relationships with others reduce anxiety.

A final thought on the disadvantages of VR is that *addiction to technology* remains a serious concern. Virtual reality, as with many other technologies, can become addictive to the user. If the VR experience is more exciting to the user than reality, the user will remain in the virtual world longer than what is required (LITSLINK 2020). VR creates a momentary escape from the real world but the danger is that the student does not want to return to the "real world" again, because the created imaginary world is more enticing. Students can become obsessed with being in the virtual world.

Despite the disadvantages mentioned in this article, the prevailing believe remains that VR holds positive gains for both academics and students. The PWC (2019) report on the use of VR indicates that a student is 3.75 times more engaged and therefore gains significantly more

insight into a topic using VR than reading a textbook. Students want to experience what they read; therefore, VR affords students the "power" to scale objects in science laboratories and visualise complex functions/objects that are more understandable to them (Babic 2019, 1; Wittenberg 1995, 12).

Where virtual reality and student engagement meets

The meeting point of VR and student engagement represents a powerful convergence of the teaching and learning experience. With VR, students can manipulate objects and hear, see, and feel the environment they find themselves in, which might otherwise not be accessible to them (Hite 2022). Several systematic research reviews were conducted to explore the relationship between VR and student engagement in learning. In a more recent research study, Allcoat and Von Muhlenen (2018, 2) examined a pre- and post-test after learning. The performance of students who made use of VR was overall more enhanced and higher engagement was reported than those who were exposed to video conditions for learning only.

Virtual reality encounters are created to mimic the real world whereby students can experience certain learning objects (ClassVR 2018; Hamilton et al. 2021, 4; Hite 2022, 106–108). Barron (2006, 58) points out that using VR simulations are created with the purpose to stimulate the user, thus increasing student engagement. VR therefore improves the sensory stimulus of students and ensures a high attention rate (Uptale 2019, 1). VR has the potential to enhance collaboration between the learner, facilitator, classroom and/or learning objects. Studies have shown (Wickens 1992, 842–847; Aczel 2017, 6–7; Alqahtani et al. 2017, 2) that when VR and training meet, endless possibilities for experiential learning are created through creative problem-solving techniques within a flexible environment (Gregory et al. 2016, 2). Literature confirms significant improvement in a student's engagement when using the virtual environment (Papanastasiou et al. 2019, 425–427).

Educational experiences are enriched through the use of immersed experiences.

RESEARCH METHODOLOGY

Research process

For this social science research study, an *interpretivist paradigm* was used as the researcher relied on dialogue between the participants to obtain a meaningful understanding of the subjects. The nature of interpretivism is that reality is socially constructed through language, shared consciousness, meaning and instruments (Krauss 2022, 11). Babbie and Mouton (2001, 28, cited in De Vos et al. 2011, 8) explain that the interpretive approach can also be called the

phenomenological approach, which, in turn, relates to hermeneutics. During the *hermeneutic* circle, a "complex whole from preconceptions about the meaning of its parts and their interrelationships" can be deduced (Klein and Myers 1999, 67–93).

This study adopted the *qualitative research* methodology. The qualitative paradigm stems from the interpretivist paradigm, which aims to understand social science (De Vos et al. 2011, 65). The *ontology* (how the researcher perceives the reality) and *epistemology* (how the researcher believes the social phenomena should be studied) assisted the researcher with choosing the *descriptive case study research design*. With case study design, the researcher can place emphasis on lessons learnt from a singular case. A descriptive case study design aims to "describe, analyse and interpret a particular phenomenon" (De Vos et al. 2011, 321).

Population and sampling process

The *population* comprised students who were registered for the National Diploma in Human Resource Management, studying via distance learning online, at a selected private HEI in the Western Cape Province of South Africa. The registration period was from 2018 to 2022. A sample of N=36 participants took part in this study. Table 2 demonstrates the participants' characteristics and educational background.

Table 2: Participants' demographic and educational background

	Open-ended Questionnaire	Interview	True Experiment	
			Experimental Group	Control Group
Mean Age of participants	48	47	38	36
Male	4	2	3	3
Female	9	1	7	7
Studied Dip in HRM			10 (100%)	10 (100%)
Postgrad and Higher-Level of Education	13 (100%)*			
VR Expert (10 years of VR experience)		3 (100%)		

*The percentages refer to the number of participants that comply

Data collection instruments and procedures

This study made use of three research instruments, namely *open-ended questionnaires, semi-structured interviews, and a true experiment,* with the *random post-test control group design.*

The open-ended questionnaire was emailed to 13 academics employed at a HEIs in South Africa. Semi-structured interviews were further conducted with three VR experts, which included international VR experts. Through a true experiment (where the design was a random post-test control group design) data such as student engagement levels and pass rates were collected from both the control and the experimental group. The same training module was

delivered to both groups. The control group received training via a distance learning online platform and the experimental group received their training in an immersive world using VR.

The study used computer-assisted qualitative data analysis software (CAQDAS), ATLAS.ti, to automate the data and present a more complex way of exploring relationships in the data and assist in developing conceptual and theoretical thinking about the data (Butler-Kisber 2018, 39). Informally, the data analysis process for this qualitative study already commenced during the data collection procedure (Lapan and Quartaroli 2009, 134; Butler-Kisber 2018, 30). Coding the data and placing the data into the various themes was a central data analysis technique used. The respondents' actual words were coded (Lapan and Quartaroli 2009, 165). To create the different themes, the researcher first analysed the data making use of concept mapping. This is a useful tool to use in qualitative research as the researcher can express different ideas/themes visually.

RESULTS AND DISCUSSION

Theme 1: Student engagement

The objective of the theme was to determine the relevance of student engagement in this current time within HEIs. The literature pointed out that South African HEIs experience high dropout rates and poor student results. Inadvertently, the literature reviews all pointed to student engagement and the role it plays in addressing these challenges. Contributing to this theme, it was imperative to determine the role virtual reality can play to increase student engagement.

The results of the questionnaire show that the majority of academics were aware of the importance of *student engagement and the potential value it has to increase the pass rate of students.* The study found that there is a definitive relationship between student engagement and the level of a student's participation in academic activities. It is therefore deduced that as student engagement increases, student success rates also increase. This agrees with the research conducted by PWC (2019, 1), Kahu and Lodge (2018, 1), Bowden and Naumann (2021, 1207–1224) and Singh et al. (2019, 301), who alluded to the fact that an immersive experience is far more exciting than traditional workplace learning and therefore VR-learning can increase student engagement levels and their recall of previous knowledge.

The questionnaire analysis was a significant predictor that students with a higher student engagement level are prone to be *critical thinkers* and are *more invested in their studies*. This is not surprising as Bowden and Naumann (2021, 1210) stress that HEIs need to place more emphasis on measuring student engagement as it provides the opportunity for the institution to measure their teaching and learning quality and create critical thinkers. Critical thinking is one

of the needed learning outcomes in higher education in the 21st century (SAQA 2021, 1). Through VR-learning, students can experience the problem "in front of their eyes", interpret and "play-around" with the possible ideas and evaluate different solutions before making a final decision.

The academics shared a thorough understanding of the multidimensional levels of student engagement that exist, namely, *behavioural, emotional, and cognitive engagement.* Therefore, the aim for HEIs should be to create the climate in which a student can experience a combination of all three engagement levels. The literature supports this finding and notes that all three engagement levels are important in a student's learning journey (Gesualdi 2019, 20; Hasanov et al. 2021, 32–33).

The study further revealed that the *availability of data and an Internet connection* still appear to be a concern among academics. This is supported by Du Plessis (2020, 1), referring to the technology accessibility gap between the rich and the poor in South-Africa. During this study, the researcher used a VR headset loaded with content that can be used offline, without any Internet connection required. This however is not the norm; for most VR headsets and programmes to run, data and an Internet connection are required.

An integral part of how students engage in learning is linked to the design of the *curriculum* and learning outcomes (Trowler 2010, 7), while not underestimating the importance of how meaningful the teaching and learning was delivered.

The results of the descriptive data further revealed that *interaction with other students and the facilitator* is more important than interaction with technology. Additionally, it is evident from the literature and questionnaires that students prefer a synchronous learning environment where discussions and probing questions can be asked by the facilitator and fellow students (Fabriz, Mendzheritskaya, and Stehle 2021, 1).

Theme 2: Virtual reality used in teaching and learning to support student engagement

The objective of this theme was to investigate the effect virtual reality has on teaching students, with the focus on how student engagement increases, or not. Literature alluded to the importance of a relationship between students engaging with one another and their engagement *with technology* (Rajabalee, Santally, and Rennie 2020, 5; Günüç and Kuzu 2014, 86–113). In this article, *engagement with technology* refers to the use of VR in teaching and learning, and not merely to the implementation of online learning. From the responses, it is evident that academics are in agreement that a more *hybrid approach* to teaching and learning is needed, where students can still interact with one another socially, be that online (or not), as opposed to

learning through VR, which lends itself to being an isolated experience.

Surprisingly, there were academics who indicated that they are not *comfortable to engage with VR* as they would need intense training, time to understand the design, and learn more about the features of what this device can do. VR further needs to be incorporated into their current curriculum and lesson plans. Notably, Hite (2022, 106–108) reports that VR applications cover mostly the niche subjects, so to find educational content might not be that easy. The literature did allude to the fact that technology has advanced rapidly the last decade, thus making it possible for individuals (or academics in this case) to develop their own VR content (Veative 2020, 1).

On a positive side, academics were of the opinion that teaching in VR is *significantly more cost- and time-effective*, as academics do not have *to spend time* on preparing for lessons. Although there is validity to some point in the statements made by academics, the researcher infers that because of the limited experience academics have with VR, capacity building around this topic is required. This is underpinned by the believe that academics will be requested to be part of the design team that creates the learning content, and this task was a concern to the academics as it can be time consuming. For HEIs concerned about the cost and time factor, it is advisable to purchase the material from VR companies that specialise in offering educational VR content.

The academics however agreed that there are several *benefits when teaching using VR.* One participant mentioned that visual learning helps students *store information for a longer period* as images are processed directly by the long-term memory to the brain. This statement supports the literature and research conducted by many researchers, one of which are the well bespoke PWC VR study conducted in 2019. The participants all agreed that the immersive nature of virtual reality *brings depth to educational content* as it enables students to use their senses and explore, thereby making it an ideal catalyst for curiosity in learning. This article alludes to the benefits VR holds in the literature section and to academics who all espoused these benefits.

IMPLICATIONS OF THE STUDY

Despite the increased interest from HEIs, there is still some hesitation and/or debate over the (1) time a student spends in a virtual environment, (2) the cost of setting up a VR learning environment, and (3) the readiness of academic staff members to adapt to a new way of teaching and learning.

In addressing the research inquiry about the impact of VR on student engagement, this research unequivocally demonstrates that VR indeed enhanced student engagement for the

study's participants. Nevertheless, it should be noted that as a standalone learning tool for HEIs, VR may not be recommended to use in isolation for the following reasons:

- High cost of developing VR content,
- practicability of all learning to be delivered through VR, and
- low adoption rates of VR learning in HEIs.

The study further revealed that the duration of a student being in an immersive virtual world should not be longer than 30 minutes at a time. Based on this premise, the study suggests that an integrated approach to teaching and learning, where the established online learning format, featuring live facilitated sessions, is combined with the innovative VR learning approach. The intervention to combine online learning with virtual learning has led to a new terminology, which for the purpose of this study the researcher referred to as the *VRL-OL framework* for teaching and learning. This outcome aligns with the research question of *student engagement* where the student engages in both the online live sessions and the virtual immersive world.

In the context of South African HEIs where poor pass rates are prevalent and challenges such as a poor Internet connection or limited data usage exist, the study suggests offering the VRL-OL experience to students by providing them with a VR headset with embedded content or alternatively, offer a semi-immersed VR experience as an offline desktop version. By offering the VRL-OL experience, students can easily access the study content without having to rely on Internet connectivity. Through the embedded learning content in VR headsets, students can become fully immersed in their VR learning, demonstrating increased levels of engagement.

To further improve the level of student engagement, the study's findings suggest that all students should complete a *VRL induction module* before engaging with the VR headset and hand controllers. The primary objective of introducing a VRL induction module is to provide students with a seamless and frustration-free experience, particularly when encountering challenges related to navigation within the virtual environment. Evidence from this study has alerted the researcher to implement a *VRL induction* programme, as there were reports from students who found it difficult to navigate or use the VR hand controls.

It is crucial to highlight that within the VRL-OL framework, an implemented code will incorporate artificial intelligence (AI) capabilities to discern and analyse the various types of student engagement exhibited during the teaching and learning phase. Data analysis reports can be built into the VR learner management system (LMS) to support reporting features such as

measuring student and lecturers' engagement levels, present assessment results, monitor student participation levels, and submitting assignments, among others. The positive adoption of the *VRL-OL framework* will largely depend on the seamless user experience and therefore the article recommends having a *pilot group of academic* staff members.

Using a *VRL-OL framework* in teaching and learning, students will most probably demonstrate improved retention and experience learning through simulation-based technology. This provides a significant opportunity for HEIs to initiate a transformative shift in their existing learning platforms, and in doing so, equipping students with 4IR skills to digitalise the workplace.

This approach encourages increased student engagement, critical thinking, and problem solving. By providing a platform for students to collaborate in the virtual world, the potential challenge of students becoming isolated can be addressed. South African HEIs should use this opportunity to foster a deeper understanding of how students prefer to learn, searching for ways to make learning enjoyable and memorable.

Academics should explore the diverse learning styles and preferences of students. Recognising the different teaching methods such as the VR-DLO approach, academics have the platform to design immerse experiences of topics that have been difficult to teach in the past.

In summary, this article highlights the importance of incorporating VR into teaching and learning, which promotes student engagement while equipping students with skills for the 4IR workplace.

CONCLUSION

The objective of this article was to determine whether VR has a positive effect on student engagement. Overwhelming evidence from this study indicates the interest HEIs have towards VR learning, as it has been confirmed that VR learning can increase student engagement and as a result, increase pass rates. The opportunity to offering student-centred learning is now possible.

As edtech enhances, the relevance of in-person training could become outdated within a few years. The focus of future education should therefore be on student-centred learning experiences through utilising VR technology. The constant evolution of technology makes it possible for HEIs to seek alternative ways of teaching and learning.

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