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The use of Virtual Reality Classrooms for Micro-teaching practice: Pre-Service Science Teachers' Experiences

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ABSTRACT

This research reports on science pre-service teachers' (PSTs) perceptions and attitudes towards a virtual reality classroom, with the rationale being to elaborate on the pedagogical affordances of technology in the micro-teaching practices of PSTs. A purposeful sample of eighty-three pre-service science teachers from a major South African university participated in the research. Data were collected following an embedded mixed methods design, with the main data collected quantitively through questionnaires supported by informal classroom conversations after the VR classroom experience. To comprehend pre-service teachers' views on technology, the study combined the UTAUT and TAM models. Data were analysed using descriptive, comparative, correlational, and content analysis methods. Results indicate that the PSTs hold a positive perception towards the use of VR classrooms for their micro-teaching and in their future science teaching. The positive perceptions of PSTs towards the VR classroom were associated with its potential to enhance task efficiency, improve teaching productivity, belief in its utility for science teaching roles, facilitate the acquisition of pertinent knowledge and skills essential for science teaching, and to provide clear and understandable interactions within the classroom. The correlation analyses identified significant associations between pre-service teachers' perceptions and their attitudes regarding using VR classrooms for their micro-teaching practices. However, there was no significant difference in pre-service teachers' perceptions and attitudes towards the use of VR classrooms for micro-teaching practice with respect to gender. Notably, their attitudes were more closely associated with their perceived performance goals of using the VR classroom. Nevertheless, pre-service teachers raised concerns about the practical applicability of the VR classroom in teaching and teacher education programs, as well as issues related to accessibility and availability of the VR device and application for pre-service teachers when outside the university. Implications for teacher education and future research are discussed.

Keywords: *Attitudes; Micro-teaching; Perceptions; Pre-service teachers; Science Education; Virtual Reality Classroom*

INTRODUCTION

Recent advances in virtual reality technology have transformed the previous pedagogical affordance of this technology from mere presentation of knowledge content to an interactive and engaging pedagogical practice. The integration of VR technology in creating a virtual learning environment (VLE) enables the visualisation of 3D data and offers interactive functionalities that intensify the sense of immersion and presence within computer-generated virtual worlds. Even though the literature on the integration of VR classrooms in educational contexts is in its infancy, researchers and educators alike assert that immersive virtual reality (IVR) applications and their affordances enhance the mastery of skills in different settings (Artun, Durukan, & Temur, 2020; Cooper et al., 2019). IVR is the most recent technology that involves the use of head-mounted displays (HMDs) and other sensory input devices to create a fully immersive experience that transports a user to a complete virtual world or simulated environment and blocks out the user's real-world surroundings (Artun, Durukan, & Temur, 2020; Chandrashekhar et al., 2023). Unlike other technologies that are currently in use to support teacher learning, such as mixed reality, which does not entirely replace the real world, augmented reality offers simpler and less immersive experiences than mixed reality or IVR, and desktop virtual reality lacks the complete sensory experience of immersion. The IVR experience is crafted to closely resemble reality, enabling users to engage with and control virtual objects and environments. As a result, the immersion, interactivity and sense of presence integrated into IVR technology enhance learning, increasing the capacity to grasp concepts more effectively and for the longer term (Krokos, Plaisant, & Varshney, 2019). Similar affordances for VR are recognised in micro-teaching, which is an essential aspect of pre-service teacher education. Within the confines of a VR classroom, several pedagogical strategies can be enacted with virtual learners and different virtual artefacts, allowing room for trial and error and critical reflections of one's practice.

In the fast-changing world where the education landscape is also changing, the exclusive use of traditional classroom settings for micro-teaching practice is deemed problematic, especially after some pedagogical insights gleaned during the COVID-19 pandemic. With the pandemic came new blended learning approaches that afforded students the luxury of remote learning in vocational training (Singh, Steele, & Singh, 2021). Due to the lockdown during the pandemic, VR classrooms emerged as a hopeful solution for training pre-service teachers remotely, bringing advantages to university education worldwide, including South Africa. For example, in an immersive virtual reality (IVR) context, users could explore, control, and modify the VR learning environment using hand-held controllers and virtual artefacts, which provides autonomy of practice with respect to controlling the learning experience (Makransky & Petersen, 2021). The current landscape of technological advancements in immersive technologies within educational settings holds the potential to impact science PSTs' learning experiences. While the integration of virtual reality classrooms could accrue several benefits, there exists a need to investigate the perceptions, attitudes and acceptance of the use of such a technological tool for training teachers using micro-teaching scenarios. Moreover, there is a dearth (scarcity) of literature on the development of VR classrooms that could be used for the vocational training of science teachers, as has been seen in other disciplines like medicine, mining, and aviation, especially within the African context. The vocational training of science teachers focuses on the use of hands-on learning experiences and real-world applications to equip teachers with the practical skills and knowledge needed for effective science teaching. VR has the potential to transform the vocational training of science teachers by providing simulated classroom environments where teachers can practice complex or dangerous experiments and procedures without risks, as well as classroom management, instructional strategies, and student interactions in a safe and controlled virtual environment. Furthermore, research has highlighted the importance of universities, especially those in developing countries, to consistently take into account the perceptions and attitudes of their students before implementing new technologies (Queiros & de Villiers, 2016). To better understand the use of VR classrooms for pedagogical training of science teachers, this study explores pre-service science teachers' perceptions and attitudes towards the use of VR classrooms for micro-teaching practice and in their future classrooms. Hence, the following research questions were posed to drive the inquiry process in this research.

1. What are the perceptions of pre-service teachers towards the use of VR classrooms for micro-teaching practice and future classroom teaching?
2. What are the attitudes of pre-service teachers towards the use of virtual reality classrooms for micro-teaching practice and future classroom teaching?

3. Is there a difference in the perceptions and attitudes of pre-service teachers towards using VR classrooms for micro-teaching practice based on gender?
4. What is the relationship between pre-service teachers' attitudes and perceptions towards using a VR classroom for micro-teaching practice?

LITERATURE REVIEW

Virtual Reality Classrooms

Virtual reality (VR) is an emerging technology that utilizes devices with stereoscopic screens and specialized equipment to generate a completely digital environment, offering a 360-degree perspective and delivering an immersive user experience that closely resembles reality (Artun, Durukan, & Temur, 2020; Donally, 2021). VR classrooms expand the applications of virtual reality to the field of education, providing immersive experiences through the use of VR collaboration tools and wearables as students interact with the three-dimensional (3D) curriculum, thereby elevating the learning process. In light of this, a VR classroom is considered a digital, computer-generated environment that simulates a real classroom setting and allows users to interact with it in a 3D space. In such a classroom, students and teachers both use VR headsets and controllers to navigate and interact with the virtual environment. Users typically have avatars that represent them in the virtual space, allowing for a sense of presence and interaction with others. According to a study conducted by Artun, Durukan & Temur (2020), the integration of VR into science education has the potential to make intangible phenomena accessible in any academic setting and can lead to significant advancement in the acquisition of science process skills. The immersive nature of VR environments captivates students' attention, enhancing the enjoyment and memorability of learned concepts. According to Lock & MacDowell (2022), immersive virtual reality fosters emotional involvement within educational settings by creating a sense of presence and involvement. Consequently, experiencing educational content from a first-person perspective in VR can make the learning experience more compelling, authentic, and meaningful. Kaser (2022) argued that VR experiences serve as excellent springboards for discussing social issues and cultivating empathy. Additionally, VR offers various advantages, such as stimulating students' creativity, igniting their imaginations, assisting those who struggle with complex academic concepts, and providing multi-sensory experiences encompassing visual, auditory, olfactory, and haptic sensations (Seth, Vance, & Oliver, 2011).

Attitudes and Perceptions

Attitudes are personal opinions or emotional tendencies, either positive or negative, that an individual holds towards the introduction of new technology in a new environment (Elias, Smith, & Barney, 2012; Huedo-Martínez, Molina-Carmona, & Llorens-Largo, 2018). Attitude consists of three components: behavioural, cognitive and affective. The emotional aspect of an attitude, which is characterized by a combination of positive and negative feelings towards an object, is at the core of the three components. The other two components are the cognitive component, which consists of beliefs about the object, and the behavioural component, which involves the tendency to act in accordance with those emotions and beliefs (Akturk et al., 2015). Understanding the attitude of in-service and pre-service teachers towards technology is very important in its integration into teaching and learning environments as well as the success of teaching processes (Akturk et al., 2015). Similarly, the perceptions of teachers contribute to the manner in which immersive technology can be embraced and disseminated (Khukalenko et al., 2022). Elias et al. (2012) argued that the successful implementation of new technologies, the willingness of teachers to use them, and their actual usage can all be impacted by attitude. However, some study findings have indicated that this attitude is contingent upon the teacher's level of familiarity and experience with technology use (Byungura et al., 2018; Queiros & de Villiers, 2016). A study carried out by Jones (2012) on the net generation and digital natives in Australia showed that confidence in using digital technologies varies among students based on their gender. Göransson & Rolfstam (2013) suggested that gender differences in the uptake of technology may be attributed to the dominance of males in the field, as most technological advancements are driven by and designed for men. Earlier studies have suggested that males tend to still hold more favourable attitudes and confidence towards the use of technology than females (Cai, Fan, & Du, 2017; Yau & Cheng; 2012). On the contrary, Ayite, Aheto & Nyagorme (2022) suggested there is no significant difference in gender when it comes to the use of technologies for academic work.

Artun, Durukan & Temur (2020) emphasized the essential role of integrating technology into the teacher education curriculum to empower pre-service teachers in facilitating students' acquisition of scientific knowledge, process skills, and affective values. Research in the field of technology-enhanced learning has revealed that the perceptions of university students and school students towards the use of virtual reality technologies are significantly shaped by their own attitudes as well as the attitudes of their educators, ultimately influencing their willingness to adopt such technology (Baxter & Hainey, 2019; Wells & Miller, 2020). Qu et al. (2015) conducted a study with 26 students from Delf University of Technology in the Netherlands, wherein the presence of spectator avatars or virtual spectators enabled students to exhibit a more positive attitude towards their self-efficacy and engage more actively during the virtual learning process. This finding underscores the fact that delivering digital content through virtual reality (VR) technologies fosters a positive attitude towards its utilization and enhances satisfaction throughout the learning journey (Khukalenko et al., 2022; Lock & MacDowell, 2022; Tsivitanidou, Georgiou, & Ioannou, 2021).

Micro-teaching practice and its role in PST development

Micro-teaching practices are simulated teaching and learning experiences designed for pre-service teachers (trainee teachers) to practice their teaching skills, with the intention of receiving feedback from their educators/peers, which leads to modifications in their practice (Campos-Sánchez et al., 2013). Micro-teaching could be used at any stage of teacher professional development (TPD) for both in-service and pre-service teachers, to provide teachers with a platform to practice their instructional strategies in a way that would reduce the setbacks and complexities in an actual classroom. Based on the dialectical relationship between doing and knowing, as proposed by philosophers like John Dewey, Jean Lave and Etienne Wenger, the learning of any skill is a social process in which knowledge is actively constructed (Lave & Wenger, 1991). This is no different in the mastery of teaching skills, where micro-teaching is used as a critical tool to nurture pre-service teachers in skill acquisition and self-reflections on their practice before they encounter real classrooms.

Some of the benefits of micro-teaching experiences are that they provide many opportunities for pre-service teachers to learn about and actively practice explicit teaching methods and strategies. This aids them in utilizing the curriculum to design and present simulations of their actual practice while reflecting on their actions. Furthermore, studies have shown that PSTs who have micro-teaching experiences have a greater chance of successful longevity in the classroom (Benedict et al., 2016; Ingersoll, 2012; Ingersoll, Merrill, & May, 2014). Hence, it becomes critical that the opportunity is created for trainee teachers to develop such skill sets through practice opportunities coupled with constructive feedback (Benedict et al., 2016; Darling-Hammond & Hyler, 2020) so that their first years in the teaching profession are approached with increased confidence, knowledge and teaching self-efficacy.

Research Context

About the Virtual Reality Classroom

Cooper et al. (2019) noted that much of the VR content available was geared towards casual experiences outside of the classroom. Hence, there remains a deficiency in VR content available on any platforms designed explicitly for, or intended as a supplementary resource for the existing teaching curriculum. This study is part of a larger project that explores the use of Learning Analytics and Virtual Reality (LAViR) applications designed explicitly for teaching specific Physics, Chemistry and Biology concepts. The LAViR virtual reality (VR) classroom is an innovative virtual learning environment (VLE) that presents a dynamic 3-D model of a science classroom. The VR classroom leverages the profound affordances of VR, including interactivity, visualisation, presence, and immersion, to give pre-service science teachers a safe space to practise their teaching of science concepts. Designed to serve as a potent tool for online virtual instruction and learning, this VR classroom enables pre-service teachers to assume two roles (as teachers or learners) with the use of avatars within the virtual classroom. The VR classroom was also used to display some scientific experimental scenarios. In the teacher role, PSTs can seamlessly navigate the VR classroom environment by presenting lessons, using virtual whiteboards, MS PowerPoint slides and videos while assessing learners' conceptual understandings using quizzes. The teachers can also teleport across the VR classroom to write on the whiteboard or assist different groups of learners during the interactive phase of micro-teaching. Furthermore, in the teacher role, PSTs can move learners within the VR Classroom to different positions in the interactive phase of the lesson.

In the learner role, PSTs can interact with 3-dimensional (3D) models, pull and examine wall charts from the wall, and write on small pallets held in their left hands for one-word answers or ideas. The 3D models are used to teach concepts in selected topics from school subjects such as Chemistry, Biology and Physics. These models are embedded in two rooms of the LAViR classroom. Learners can also interact with 3D models and write on the whiteboard as coordinated by the teacher in the course of the lesson. The unique feature of the LAViR classroom is that it is embedded with cameras that feed into a spectator view and a learning analytics dashboard to enable observation by teacher educators and reflective practice. This application, hence, expertly upgrades traditional classroom settings, elevating the learning experience through real-time interaction between learners, teachers, and teacher educators.

The VR classroom, as part of the LAViR application, provides an alternative way for PSTs to develop their skills and knowledge prior to teaching in a classroom with 'real' learners. The VR platform provides a practice-based opportunity for teachers to enact lessons using diverse artefacts like avatar learners (who, in this case, are their peers), 3D models of concepts in science, charts, whiteboards, slides, videos and many more to gain mastery of teaching methodology (see Figure 1). Virtual reality classrooms have the extra advantage of being neither time nor place-bound as long as there is Internet connectivity and the relevant devices for enactment. The virtual reality classroom is also a safe space where no direct error could affect vulnerable students in an actual classroom (Dieker et al., 2014).

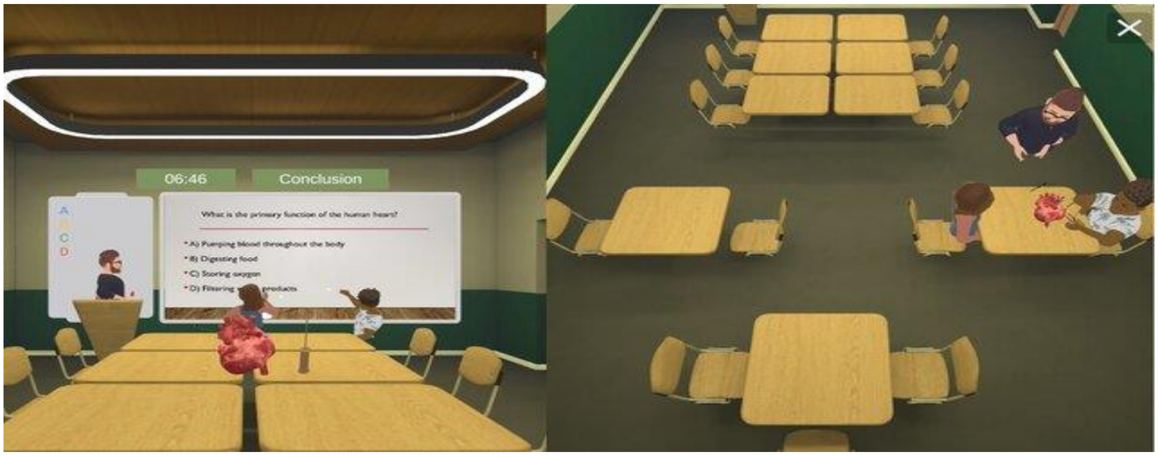

Figure 1: A screenshot of the LaViR environment

Conceptual Framework

This study used an integrated model that combines the Unified Theory of Acceptance and Use of Technology (UTAUT) and the Technology Acceptance Model (TAM) as a conceptual framework to guide the investigation of preservice teachers' perceptions and attitudes towards the use of VR classroom for micro-teaching practice (Davis, 1986; Vankatesh et al., 2003). Several theories have been developed to explain why people adopt new technologies (Davis, 1989; Venkatesh & Davis, 2000). For example, the Technology Acceptance Model (TAM) is a prominent theory that focuses on how beliefs about a technology's usefulness and ease of use influence people's attitudes and intentions to use it. TAM suggests that if people believe technology will help them do their job better and is easy to use, they are more likely to adopt it. Perceived ease of use refers to how easy someone thinks a system will be to use (Davis, 1989). The UTAUT model developed by Venkatesh, Morris, Davis, and Davis (2003) combined previous research, including the TAM model, to create a more comprehensive framework for understanding technology adoption (see Figure 2). The UTAUT model included performance expectancy and effort expectancy, which are similar to perceived usefulness and ease of use in the technology acceptance model.

While the UTAUT model highlights the importance of effort expectancy (ease of use) in technology adoption, its impact might diminish over time. Therefore, perceived ease of use can be expected to be more salient only in the early stages of using a new technology such as the LAViR application, and it can positively affect the perceived usefulness of the VR technology. This study combines the UTAUT and TAM to investigate how pre-service teachers perceive and use IVR classrooms for micro-teaching. UTAUT focuses on factors like performance expectations, ease of use, social influences, and facilitating conditions, while TAM emphasizes perceived usefulness and ease of use. The integration of these two models provides valuable insights and a comprehensive understanding of how pre-service teachers perceive the adoption and use of IVR classrooms for micro-teaching practice.

In this study, performance expectancy refers to pre-service teacher's perception of the extent to which using the VR classroom will improve their micro-teaching experience or make teaching easier and more efficient. While effort expectancy reflects pre-service teacher's perception of the ease with which they can use the VR classroom, encompassing factors like complexity, ease of learning, and user-friendliness. The implementation of VR technology in public education in South Africa is yet to be publicly realized. As a result, this study was conducted as a baseline study to explore the pre-service teachers' attitudes and perceptions of VR classrooms, aiming to identify measures to improve the actual use of the technology for micro-teaching practice and in their future classrooms.

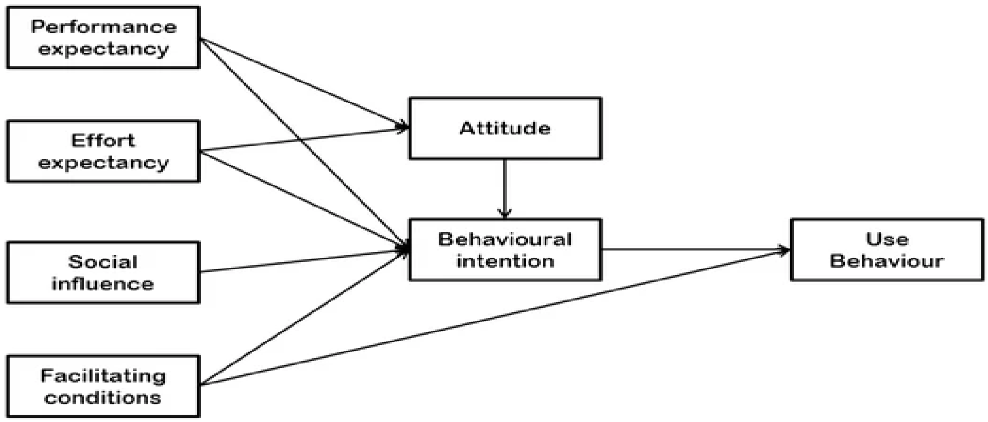

Figure 2: Conceptual model (Source: Adapted from Venkatesh et al. 2003)

METHODOLOGY

The study used the embedded mixed methodology to explore the perceptions and attitudes of preservice teachers towards using a Virtual Reality classroom for micro-teaching practice (Kroll & Neri, 2009). The study commenced with a quantitative online survey designed based on the UTAUT instrument by Venkatesh et al. (2003) and the TAM instrument developed by Davis (1989). The instrument is divided into two sections. The first section contained preservice teachers' demographic information, including age, gender and subject of specialization. The second section consists of six constructs that were quantified on a five-point Likert scale ranging from strongly disagree (coded as 1) to strongly agree (coded as 5). These constructs were categorized as performance expectancy, effort expectancy, attitude, social influence, facilitating conditions, and behavioural intention. In this study, the focus is on three primary constructs: performance expectancy, effort expectancy (as these are directly related to perception) and attitude. As a result, students' attitudes toward using VR classrooms for their micro-teaching practices were assessed using four questions adapted from Davis (1989). A subset of four questions from Venkatesh et al. (2003) was employed to measure performance expectancy and effort expectancy. The wording of the adapted questions was modified to suit the context of this study. To ascertain the accuracy and effectiveness of the adapted question, a pilot study was conducted with ten Bachelor of Education Honors students who were not part of this study. The questionnaire was later designed using Google Forms, and the link was sent through a group WhatsApp platform once students completed their micro-lesson presentations in the VR classroom. Data obtained from the questionnaire were analysed using descriptive statistics.

A three-level rating scale was created to interpret the data. The lowest range of the Likert scale was subtracted from the highest range (5-1) and later divided into three equal intervals. Each interval represented a specific rating: low, moderate, or high. The mean value for each statement determined its placement within these intervals. Based on this criteria, the index score for each statement is categorized as follows: a mean value less than 2.33 indicates a low rating (negative perception and attitude), between 2.34 and 3.67 indicates a moderate rating (neutral perception and attitude), and more than 3.68 indicates a high rating (positive perception and attitude). Following the quantitative data collection, informal classroom conversations were held with participants to delve deeper into their experiences with the VR classroom (Swain & King, 2022).

These discussions focused on participants' experiences in using the VR classroom, perceptions of the VR classroom's effectiveness for micro-teaching and its potential for future classroom teaching. These informal classroom conversations not only helped to provide additional insights but also helped to better understand the quantitative results. Findings from the informal conversations were analysed using content analysis.

The research subjects were third-year pre-service teachers registered in a secondary STEM teacher education program within the Faculty of Education at a large Metropolitan university in South Africa, where the use of advanced learning technologies is strongly embraced. Data were collected in August 2023 after approval to conduct research was obtained from the University's research ethics committee. A purposive sampling method was chosen for this study because the target group had completed most, if not all the science content knowledge in their teacher education program and had access to the IVR classroom. Additionally, this group had compulsory assessments that were directly linked to their micro-teaching practices. As a result, eighty-three students taking a science specialization in the Bachelor of Education programme participated in the survey. In addition, 42.2% were male and 57.8% were female. 95.1% of the participants were between 18 and 25, while 4.9% were between the ages of 26 and 30. Participants were from various combinations of subject area specializations: Natural Science and Life Sciences (n = 8), Life Sciences and Physical Sciences (n = 29), Physical Sciences and Mathematics (n = 10), Life Sciences and Mathematics (n = 5); Life Sciences and ICT support (n = 2), Life Sciences and Geography (n = 17), and others (n = 12). Prior to using the LaViR application, the pre-service teachers had undergone specific training as part of their teacher education program, so they were familiar with the VR technology. The initial training focused on mastering the operation of VR controllers and navigating various interfaces and tools within the VR device, as depicted in Figure 3.

Figure 3: Pre-service teachers navigating the LaViR application

The quantitative survey form was designed using Google Forms. The respondents filled in the answers by clicking appropriate boxes and submitted their responses to a Web server, which was used to administrate the survey. All respondents' inputs were recorded in an Excel table. Data were analysed using descriptive statistics and correlation analysis. Furthermore, a reliability analysis was conducted on the scales using Cronbach's Alpha, and the results showed that the internal consistency for the constructs was moderate to high, with performance expectancy at 0.58, effort expectancy at 0.76, and attitude at 0.79. These values indicate that the scales have a reasonable degree of reliability, as they are all above the threshold of 0.50, as suggested by Hinton, McMurray, and Brownlow (2014). Patterns isolated from analysing the content of classroom conversations are also reported to support the quantitative findings. All ethical considerations were adhered to regarding the anonymity and confidentiality of participants.

RESULTS

Research question 1: Perception towards the use of VR Classroom for micro-teaching practice

The first step in analysing the data was to provide descriptive statistics for the participants' responses. The response to each statement was scored on a scale of 1 to 5, with higher scores indicating the highest perceptions and attitudes towards using a VR classroom for micro-teaching practice. The results in Table 1 show that the majority of pre-service teachers (58.5%) strongly believe that using an immersive virtual reality classroom would be beneficial in their role as science teachers. Additionally, a significant number of respondents (46.9%) strongly agreed that utilising the IVR classroom would boost their productivity and help them, while 47.6% agreed that it would help them acquire important skills and knowledge appropriate for teaching science. Overall, the mean values for all items related to performance expectancy ranged from 4.11 to 4.32, indicating a high level of positive perception.

Table 1: *Descriptive Statistics for Performance Expectancy*

	Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**	**Mean**	**Std Dev**
I would find the IVR classroom useful in my job as a science teacher	6 (7.3%)	0 (0.0%)	4 (4.9%)	24 (29.3%)	48 (58.5%)	4.32	1.099
Using the IVR classroom will enable me to accomplish tasks more quickly	1 (1.2%)	0 (0.0%)	12 (14.6%)	39 (47.6%)	30 (36.6%)	4.18	.772
Using the IVR classroom will increase my productivity.	1 (1.2%)	0 (0.0%)	8 (9.9%)	34 (42.0%)	38 (46.9%)	4.33	,758
If I use the IVR classroom, I would have more chances for a career	1 (1.2%)	3 (3.7%)	14 (17.1%)	32 (39.0%)	32 (39.0%)	4.11	.903
Overall Performance Expectancy						**4.21**	**.604**

The results in Table 1 indicate that participants demonstrated a positive performance expectancy, expressing a strong belief that the adoption of the VR classrooms would enhance their job performance, streamline tasks, and contribute to increased efficiency. The data in Table 2 shows that two statements, “My interaction with the VR classroom will be clear and understandable” (EE1), and “It will be easy for me to become skilful at using the IVR classrooms” (EE2) demonstrated the highest mean (M = 4.15, SD = .705; M = 4.12, SD = .812) respectively, indicating a high degree of agreement among pre-service teacher perceptions towards the use of VR classrooms in terms of performance expectancy.

Table 2: *Descriptive Statistics for Effort Expectancy*

	Disagree	Neutral	Agree	Strongly Agree	Mean	Std Dev
My interaction with the IVR classroom will be clear and understandable	0 (0.0%)	15 (18.3%)	40 (48.8%)	27 (32.9%)	4.15	.705
It will be easy for me to become skillful at using the IVR classrooms	2 (2.5%)	16 (19.8%)	33 (40.7%)	30 (37.0%)	4.12	.812
I will find the IVR classroom easy to use	5 (6.1%)	34 (41.5%)	29 (35.4%)	14 (17.1%)	3.63	.839
Learning to operate/use the IVR classroom will be easy for me	4 (4.9%)	30 (37.0%)	33 (40.7%)	14 (17.3%)	3.70	.813
Overall Effort Expectancy					**3.89**	**.624**

The overall high mean score in Table 2 indicates that participants exhibited a favourable effort expectancy, anticipating that the VR classroom (LaViR application) would be user-friendly, easy to learn, and require minimal effort. The combined results in both Tables (1 and 2) suggest that the majority of students had a positive perception of using virtual reality classrooms for micro-teaching practice. This may be attributed to the student's evaluation and appreciation of the affordances of advanced learning technologies such as virtual and augmented reality, for basic and higher education delivery in South Africa. Such a positive perception about using IVR classrooms for micro-teaching practice was expected to enable students to develop a positive attitude towards the use of IVR classrooms in their future classrooms.

In addition, content analysis of the informal discussions with participants further highlighted preservice teachers' favourable perceptions towards utilising immersive virtual reality classrooms. This observation was made when a cohort of participants shared their belief that employing virtual reality classrooms for their micro-teaching endeavours would be highly innovative and exceptional. They also acknowledged that this approach would have been an enriching experience if it had been employed to assist students in their micro-lessons during the pandemic. Another cohort of participants also mentioned that learning how to navigate the device *"is a very interesting experience*" that has helped them to "*become more confident in using technology*". Some of the participants also mentioned that they used to be scared, thinking VR is very delicate to operate, but they realised that it is something really enjoyable and motivates them to try new things. One participant noted,

> "*With the absence of teacher educators in this virtual space, I will have the freedom to engage in activities as I like, giving me independent accomplishment without the scrutiny of others watching me".*

However, participants mentioned that for IVR classrooms to truly be relevant in teaching or teacher education, every student should possess and have access to a headset. Furthermore, they emphasized the importance of accessibility. Therefore, the question arises: How accessible is it, and how practical is it? Students also voiced concerns about how VR technology might be used in external settings outside the University. They also enquired about additional resources that may be made available in order to guarantee that all preservice teachers can take advantage of these benefits.

Research question 2: Attitude towards the use of IVR Classroom for Micro-teaching Practice

Pre-service teachers' attitudes towards using virtual reality classrooms for micro-teaching practice were evaluated using four questions in Part B of the questionnaire. The distribution measures of the general attitudes index are presented in Table 3. The results showed that pre-service teachers generally had a positive attitude towards using immersive virtual reality classrooms for micro-teaching practice, with the highest agreement on the statement "The exploitation of the virtual reality classroom could make teaching more interesting" (M = 4.44, SD = .866) with 59.9% of respondents strongly agreeing.

Moreover, the results showed that the arithmetic mean score of preservice teachers' attitudes towards the use of IVR was between "neutral" to "strongly agree" as $\bar{x}$ =4.34 (7> $\bar{x}$ <49). According to this result, it can be claimed that the level of preservice teachers' attitudes towards using immersive virtual reality classrooms for micro-teaching practice and in their future classrooms are more leaning towards "strongly agree" from the "neutral" interval scale.

Table 3: *Descriptive Statistics for Attitude towards using VR classroom*

	Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**	**Mean**	**Std Dev**
Using the VR classroom system could be a good idea	0 (0.0%)	1 (1.2%)	9 (11.0%)	34 (41.5%)	38 (46.3%)	4.33	.721
The utilization of the VR classroom could make teaching more interesting	2 (2.5%)	2 (2.5%)	2 (2.5%)	27 (33.3%)	48 (59.3%)	4.44	.866
The exploitation of the VR classroom could be fun.	3 (3.7%)	2 (2.5%)	5 (6.2%)	23 (28.4%)	48 (59.3%)	4.37	.980
I will use the VR classroom with pleasure	1 (1.2%)	1 (1.2%)	6 (7.4%)	38 (46.9%)	35 (43.2%)	4.30	.766
Overall attitude						**4.34**	**.709**

Research question 3: Perception and Attitude Towards the Use of IVR Classrooms for Micro-teaching Practice with Respect to Gender

Independent t-tests were conducted to examine potential gender differences in perceptions and attitudes of sampled participants towards using IVR classrooms for their micro lesson presentation and its potential use in their future classrooms. Results indicated no overall gender-based differences in their attitudes as presented in Table 4. However, a closer look at the mean value of the three factors individually for both groups revealed some variations. Findings show that females reported a higher mean in attitude (M = 4.39, SD = .685) and performance expectancy (M = 4.30, SD = .582) than in Males, where the attitude was (M = 4.26, SD = .747) and performance expectancy (M = 4.11, SD = .625). However, the males tend to report a higher mean in Effort expectancy (M = 3.92, SD = .627) than the females (M = 3.86, SD = .628).

Table 4: *Independent sample t-test t*

		Levene's Test for Equality of Variance							
		F	Sig	t	df	1 Sided p	2 sided p	Mean difference	Std Error difference
Attitude	**Equal variance assumed**	.350	.556	-.777	81	.220	.440	-.12287	.15816
	Equal variance not assumed			-.766	69.499	.223	.446	-.12287	.16038
Performance Expectancy	**Equal variance assumed**	.043	.836	-1.447	81	.076	.152	-.19320	.13348
	Equal variance not assumed			-1.431	70.269	.078	.157	-.19320	.13500
Effort Expectancy	**Equal variance assumed**	.024	.876	.433	81	.333	.666	.06032	.13941
	Equal variance not assumed			.433	73.500	.333	.666	.06032	.13937

Research question 4: Relationship between pre-service teachers' perceptions towards using a VR classroom for micro-teaching practice and their attitudes.

Pearson Product-Moment Correlation Coefficient analysis was performed to analyse the relationships between the scores on pre-service teachers' attitudes towards technology and their perceptions. Attitude was positively related to performance expectancy (r = .597, $p < .01$) and effort expectancy (r = .412, $p < .01$). The correlation between attitude and performance expectancy is the strongest among the three correlations, as shown in Table 5.

Table 5: *Correlation among Variables*

		Attitude	Performance Expectancy	Effort Expectancy
Attitude	Pearson Correlation	1	.597**	.412**
	Sig. (2-tailed)		<.001	<.001
Performance Expectancy	Pearson Correlation	.597**	1	.463**
	Sig. (2-tailed)	<.001		<.001
Effort Expectancy	Pearson Correlation	.412**	.463**	1
	Sig. (2-tailed)	<.001	<.001	
**. Correlation is significant at the 0.01 level (2-tailed).				

Simple linear regression analysis was conducted to examine the direction and strength of the relationship between pre-service teachers' attitudes towards the VR classroom and their perceptions. Findings show that there is a statistically significant linear relationship between pre-service teachers' perceptions (performance expectancy and effort expectancy) and their attitudes towards VR classrooms (Table 6). In order words, the strong correlation found among the three variables suggests that students' perceptions about the use of VR classrooms have a positive influence on their attitudes towards using IVR classrooms for micro-teaching practice.

Table 6: *Analysis of Variance (ANOVA)*

Model		**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
1	Regression	15.670	2	7.835	24.437	<.001[b]
	Residual	25.649	80	.321		
	Total	41.319	82			
a. Dependent Variable: Attitude; b. Predictors: (Constant), EE, PE						

DISCUSSION

South Africa's education system is undergoing a transformation, with digital teaching methods rapidly gaining popularity over traditional classroom approaches due to the country's strategic focus on harnessing emerging technologies of the fourth industrial revolution. As a result, this study examined how pre-service STEM teachers at a South African university viewed the practicality and usability of immersive VR technology. The study focused on understanding how these opinions influenced their willingness to use IVR classrooms for micro lesson teaching and future classroom practices. The findings of the study revealed a generally positive perception among pre-service teachers regarding the use of virtual reality in education, demonstrating that they strongly agree that the integration of VR classrooms would influence their micro-teaching practices and future classroom activities positively. The positive perceptions of these pre-service teachers are primarily linked to their awareness of its utility and interest in using VR, supporting the findings of previous studies (Li, Liu, & Chen, 2023; Yilmaz & Simsek, 2023). All participants acknowledged the significance and benefit of utilising the immersive virtual reality classroom to obtain pertinent knowledge and digital competencies required for teaching science. These abilities and knowledge could assist pre-service teachers to improve their methods of teaching and prepare them for a professional job that allows them to use cutting-edge technology while maintaining high standards of teaching and learning (Cooper et al., 2019; Yilmaz & Simsek, 2023). Similarly, the findings of this study revealed that pre-service teachers' attitudes towards the use of VR classrooms for their micro-teaching practices were positive. This result is consistent with other studies that investigated pre-service teachers' attitudes towards virtual reality technology (e.g. Cooper et al., 2019; Li, Liu, & Chen, 2023). Immersive virtual reality classrooms can offer pre-service teachers the chance to engage in interactive simulations and virtual experiments replicating real-life laboratory scenarios. This immersive experience deepens their understanding of scientific concepts and empowers them to investigate different pedagogical approaches to make science more accessible and captivating for their future students. If pre-service teachers perceive the VR classroom as a tool that assists them in developing practical teaching abilities within a controlled and encouraging environment, they might view it positively (Artun, Durukan, & Temur, 2020).

The results of this study also indicate that the perceptions and attitudes of pre-service teachers towards the use of virtual reality classrooms in their micro-teaching sessions is influenced by their belief that utilising virtual reality classrooms improves their teaching ability and broadens the scope of classroom effectiveness (Li, Liu, & Chen, 2023). Furthermore, it was found that gender does not affect pre-service teachers' perceptions and attitudes toward using VR classrooms for their micro-teaching practices, supporting the findings of Ayite, Aheto, and Nyagorme, (2022). Although pre-service teachers hold favourable views and attitudes towards the VR classroom in their micro-teaching and future classrooms, they also expressed concerns about its practical application in the longer term. Concerns were expressed about pre-service teachers' access to a VR headset based on its price value and availability of the specific VR learning application outside the university. These concerns may present limited opportunities for pre-service teachers to use VR classrooms in their teaching, teacher education programs, or schools (Cooper et al., 2019).

However, results from this study should be interpreted with caution because of the restricted sample used. Thus, it is unclear what the results would be if a larger sample of pre-service teachers across various years of study in their teacher education program or from other universities in other parts of the country were to be used. Therefore, further research is recommended to supplement the findings of this study. Since this study was conducted as a baseline assessment to optimise pre-service teachers' experience when exposed to VR classrooms for micro-teaching, assessing their actual experiences and how they integrate this technology into their pedagogy is likely to be of interest to various stakeholders.

CONCLUSION

Pre-service teachers' acceptance of IVR classrooms in higher education institutions is crucial for its effective implementation, as it is influenced by their perceived views about the use of IVR technology and not their prior experience with VR. In addition, it is essential to emphasize that while the adoption of IVR classrooms is important in teacher education programs, the key factor for success lies in the quality of the content. If the content is not well-designed to fit the current teaching syllabus and enhance learning outcomes and student engagement, the full potential benefits of using IVR classrooms may not be realized. To ensure that IVR classrooms are utilized as an effective teacher training tool, higher education institutions that intend to incorporate VR into their teacher education programs must offer essential institutional support and training programs and create an enriching experience with VR for students. A positive and enriching experience can be provided by investing in or developing IVR applications that can allow students to interact with each other in virtual environments, thereby facilitating collaborative learning. Furthermore, virtual laboratories can be created for practical subjects, enabling students to conduct experiments and simulations in a safe and controlled setting. Also, institutions must ensure that VR content is accessible to all students, regardless of any physical or cognitive limitations they may have. The inclusion of these elements during teacher education can lead to a more favourable attitude among pre-service teachers because they tend to become more inclined to embrace VR if they feel sufficiently prepared and supported in its utilization (Li, Liu, & Chen, 2023). Furthermore, decision-makers and relevant stakeholders need to take into account issues of accessibility when developing strategies for the use of virtual reality classrooms in teacher education programs and schools.

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