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Enhancing student engagement in vocational education by using virtual reality

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Abstract

In education, particularly vocational higher education, student involvement is a challenge. Teachers can use virtual reality to bring real-life events into the classroom, encouraging active learning and student participation. Virtual Reality (VR) can be employed in various ways using a simple, easy and helpful application that can be difficult to execute pedagogically Three research methods were conducted in a classroom setting, with total simulation using VR oculus rift technology, and data analysed using desktop computer theme analysis. Students from engineering departments took part in the research, using VR to boost student learning engagement. According to the statistics, VR appears reasonably simple to use, and students feel it enhances their comprehension and engagement. According to this preliminary research, VR environments provide an intense presence, enhancing student engagement and motivation. This conclusion supports the findings of prior investigations.

Keywords

Pedagogy; student engagement; virtual reality; vocational education

Introduction

When learning or being taught, a student's interest, curiosity, excitement, passion and eagerness to learn and grow are referred to as student participation in education (Christopoulos et al., 2018). The concept that learning is better when students are intrigued, motivated, or inspired by what they are studying, rather than bored, discontent or disengaged, underpins student participation in general. On the other hand, student participation is frequently identified as a concern in higher education (Colin Bryson, 2014). In learning, efforts are needed to increase student involvement in higher education, namely problem-based learning approaches and active learning (Garduño et al., 2021).

In higher education, student involvement serves both institutional and individual development goals. Favourable policies and practices directly related to student involvement in boosting higher education production exist at higher education organisations (Kuh & Hu, 2001). Management in higher education will be able to identify activities that include students in attempts to enhance higher education

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with the support of student involvement (Pike, G. R., & Kuh, 2005). Improving student learning outcomes is a goal shared by all stakeholders in higher education. It aligns to the enhancement of the student experience. Furthermore, students must be fully engaged in their studies to attain their full potential and reap the benefits of such involvement. As a result, student involvement is one of the most important notions to develop in education in the 21st century.

The rapid development of information communication technology (ICT) in the current era of globalisation cannot be ignored in terms of its impact on education. Global needs demand that education adopts technical changes to improve quality, particularly in modifying the use of information and communication technology in the learning process. Globalisation has sparked a trend in education to migrate away from traditional face-to-face sessions and towards more flexible approaches to learning. Education in the future will be available to anyone who requires it, regardless of age, type, or previous educational experience. Information networks that allow interaction and collaboration will play a more significant role in future schooling. These developments include greater access to learning resources, more options for using and utilising ICT, and a growing role for media and multimedia in educational activities.

When teachers actively provide students with the opportunity to use technological tools in a blended learning setting, it can boost student engagement at the elementary, middle, high school, and college levels. Lesson plans must include information on how to plan and apply technology to fulfil pupils' requirements. Students can learn and explore a new academic topic or enhance their understanding of past content using a combination of print and digital technologies in blended learning. Before teaching synchronous classes, technology can also be utilised to front-load content. Teachers must use technology appropriately to boost student involvement as they compete with digital media. Using technology to engage students in the learning environment allows for a sense of community, accessibility, support, motivation, interest in learning and self-regulation (Bond & Bedenlier, 2019).

Vocational education in Indonesia

Education is one of the most significant contributors to every country's progress. According to Article 1 of the Law of the Republic of Indonesia, Number 20, 2003, education requires a conscious and planned effort to create an atmosphere to support the learning process. Students actively develop their potential to have religious-spiritual strength, self-control, personality, intelligence, noble character, and the skills needed and acquired through the learning process. Students are community members who attempt to improve their potential through a learning process—offered at various degrees, levels, and types of education (Article 4). As a result, education may be defined as a purposeful and organised endeavour to establish an environment and learning process that allows pupils to develop and explore their full potential (e.g., talents, interests and abilities).

Vocational education is training for the workplace (Sudira, 2016). Traditionally, the fundamental purpose of vocational education has been to provide direct preparation for work. Students' motivation can be fuelled by the prospect of financial gain in the future. Most governments in Western nations have adopted competency-based training as a paradigm for vocational education (Pavlova, 2009). The vocational education tradition aims to prepare graduates for work. Vocational education contains special training that tends to be reproductive, according to the orders of teachers or instructors, focusing on developing industrial needs, retaining special skills, or market tricks.

The fundamental motivation for vocational education is to gain future economic rewards. As a paradigm of vocational education, competency-based training was adopted. Vocational education prepares a skilled workforce accountable to the business (Rojewski, 2009). According to Sudira (2016), vocational training is held for at least four main objectives: 1) preparation for working life, which includes providing insight into their chosen work; 2) initial preparation for individuals for working life, which includes self-capacity for the chosen work; 3) long-term capacity development for individuals in their working life, which includes the ability to carry out further work transformations; and 4) provision of educational experience to support vocational education, which is distinguished by the fact that it combines the functions of both education and training. Vocational education has the potential to produce a person with sufficient theoretical and academic foundation, as well as the capacity (competence) to operate according to specified competency standards. Given the current state of human resource preparation, the appropriate policy is to choose vocational education as a model for developing Indonesian human resources with competitive and acceptable capacities. This situation necessitates the continual development and systematic efforts to promote vocational education, in a way where national higher education development strategies are institutionally sustainable.

It is timely for the Ministry of Education, Culture, Research, Technology, and Higher Education of the Republic of Indonesia to review the strategic objectives of vocational education development, which include: (1) improving the quality of learning and student affairs in higher education; (2) improving the quality of science and technology and higher education institutions; and (3) increasing the relevance, quality and quantity of vocational education. This viewpoint is consistent with the higher education system's framework, as stated in Article 19 of the Law of the Republic of Indonesia (No. 20), 2003, regarding the National Education System, which says that higher education offers vocational, undergraduate, masters, specialist and doctoral programmes. It is a challenge for higher education to develop the vocational education system systematically and adequately prepare its tools, as stated in Article 20 (para. 3) to organise academic, professional and vocational programmes. The polytechnic is one of Indonesia's vocational education providers.

Polytechnics are an important higher education component of the National Education System that creates Human Resources (HR) with necessary practical capabilities. Polytechnic education is a postsecondary level vocational education programme that provides graduates with skills and sufficient theoretical knowledge, as well as a robust disciplinary mindset. As a result of this provision, polytechnic graduates will become vocational employees in their professions, particularly in engineering and commerce (Law of the Republic of Indonesia, No. 12, 2012).

The primary goal of polytechnic education in Indonesia is to generate knowledgeable and skilled graduates. However, it falls short of the industry's requirements, putting polytechnic graduates at a disadvantage in the labour market. Polytechnic education is designed to suit the needs of industry professionals. The polytechnic's goal is to prepare students to become productive human beings who can work independently and fill employment openings in the business and industrial world as middle-level workers, based on their skill programme competencies. Diploma-III, Applied Bachelor (Diploma-IV), Applied Master, and Applied Doctor are the current educational levels at the polytechnic. The polytechnic curriculum teaching and learning system differs from the academic education programme. Polytechnic education places a premium on hands-on learning through a customised package system, mirroring industry. Every student is required to complete all the courses in the programme. The number of courses with total credits every semester is how this system is translated.

The quality of learning must be improved to achieve the goals of polytechnic education so that developing knowledge is a process of interaction between lecturers and students. High-quality learning in polytechnics will be more likely to produce positive learning outcomes (Goodrum & Rennie, 2008). For example, lecturers must deliberately and explicitly construct learning scenarios for learning processes to be more successful (Schunk, 2012).

Virtual reality in education

Virtual reality (VR) is a dependable teaching tool, particularly for student motivation and involvement (Papanastasiou et al., 2019). As a result, universities are considering investing enormous resources (human resources, cash, and infrastructure) in VR, particularly immersive VR, which differs significantly from how VR is utilised in cyberspace. In higher education, the immersive VR experience boosts learning outcomes (Makransky et al., 2019), so it is appropriate to determine how immersive VR technology may be employed in higher education. Empirical support for its utilisation can be determined by considering VR's educational applications.

The two types of VR are non-immersive and immersive (Ventura et al., 2019). Non-immersive virtual reality (NVR) is a kind of VR that is frequently discussed in academic articles (Moloney et al., 2018; Wu et al., 2021; Yoon et al., 2020). Scenario-based approaches can present the VR environment and its interactions on a conventional computer monitor, and non-immersive VR provides superior cognitive outcomes and learning attitudes than traditional teaching approaches (Artun et al., 2020). Desktop VR simulations have a motivating effect. Immersive VR displays the virtual environment through an attached headgear with controlled interaction and utilises a monitored handheld device for input and a forward movement detection system. This is particularly useful when used in conjunction with a smartphone, personal computer unit, or a laptop.

In contrast, non-immersive VR displays the virtual environment on a standard screen (Thisgaard & Makransky, 2017). According to (Scavarelli et al., 2021), software development will replace hardware and memory storage, and immersive VR will become commonplace. Nonetheless, implementation will be tricky because special software is for educational application demands (Howie & Gilardi, 2021).

Virtual reality has been used to help teaching and learning processes in various fields (Dommett, 2018). For example, creating a virtual laboratory crash in a simulated facility has demonstrated the pertinent needs for safety procedures for chemical engineering students. Students learn more when 3D design representations are employed in a virtual experience, in the case of human anatomy (Maresky et al., 2019). Researchers have debated the use of immersive virtual reality in engineering education (Stojšić et al., 2017). Immersive experiences offer the potential to give students more control over their learning activities and increase engagement (Ruiz-Cantisani et al., 2020). Such control is essential since one of the disadvantages of technology-assisted learning is a lack of student ownership in the learning process. Students' involvement and ownership of learning activities can be boosted by involving them in a process that provides autonomy and control over where they move in a virtual 3D world. Compared to desktop VR, immersive VR technology creates a higher sensation of presence but lower levels of learning, according to previous studies focusing on learning outcomes (Grivokostopoulou et al., 2020). On the other hand, immersive VR technology improves learning rates. No studies have been achieved on student engagement by adopting immersive state-of-the-art VR in higher education (Hernandez-de-Menendez et al., 2020; Passig et al., 2016; Webster, 2016). This article reports research about the effect of using instructional media on the level of student engagement in learning. The methodology is discussed in the next section.

Methodology

This research was a preliminary study investigating virtual reality in vocational education learning. The goal was for students to engage in immersive VR experiences related to their education, and then reflect on specific learning objectives because of those experiences (Alhalabi, 2016; Portman et al., 2015). The research pilot was based on strong pedagogical principles and matched the existing curriculum. Students were asked to think about their experiences and how useful they thought they were. This study sought to determine whether the immersive effect of VR improved student involvement and educational outcomes. It also focused on basic user experience concepts (Reeves & Crippen, 2021). Experimental approaches and questionnaires were employed.

Participants

The poll had 36 participants (n=36): electrical engineering students (n = 12) and electronic engineering students (n = 24) within teaching groups. Every person who participated was a student. After gaining ethical consent, all participants were given information about the study and signed consent forms. The experiment was divided into two groups, one for electronics engineering students and the other for electrical engineering students, for three experiments. Students ranged in age from 18 to 20 years old and were of mixed gender. Electronic engineering students focused on VR for robots, while electrical engineering students focused on power plants. Below is a more detailed description of the class and each group.

Methods

The idea that VR can be used for specific outcomes was the focus of this research. The objectives for the electronics engineering and electrical engineering classes were established to align accordingly. On a Likert scale, specific learning objectives and other questions about the ease of use of VR technology were rated. All students were given a five to 10-minute explanation, as a brief introduction. This was done to provide context and clarify the aim of the research. Following the description, participants watched a VR simulation film of each group's activities, commented on the lecturer's learning objectives, and completed a questionnaire. One Oculus Rift headset was utilised in the two trials, in the context of electronics and electrical engineering. This study focused on how individuals used the tool and viewed it as a learning aid.

There were three experiments, which were repeated three times. Students were expected to read specific learning objectives in each experiment. After that, we asked them whether they believed that using VR would help them better comprehend each of the three learning objectives for the session. Each trial was assigned a number between two and four, then evaluated in order. Experiment 1 generated quantitative data. Quantitative data from each trial was analysed to determine whether immersive VR technologies could aid students in comprehending specific learning objectives (ranked 2–4), and to determine whether student motivation resulted in higher attendance levels and cognitive processing, thereby leading to higher levels of knowledge (Makransky et al., 2019). Table 1 shows the group’s experiments and activities.

Table 1. ***Group Experiments and Activities***

Experiment Group	**Activities**
Group 1 Students in electronics engineering view a demonstrated VR robotic simulator	Students participated in a VR robotic simulation to: • Learn about robots and their role in industrial automation • Develop knowledge of robotics in industrial automation, according to the curriculum • Extend their visual understanding of robotics
Group 2 Electrical engineering students simulate a power plant	This class's pedagogical purpose was to design a VR simulation power plant to detect, analyse, and reflect emotional engagement in sensory perception as phenomena and ideas for VR research.
Group 3 Electronic and electrical engineering students participate in a three-day VR headgear trial	Oculus Rift S VR was used to view genuine virtual reality items. Free VR education apps include Google Earth VR, Home – A VR Spacewalk, International Space Station Tour VR, Medical Realities Platform Desktop, Teacher's Lens Beta, Pollinator Park, and Space Dreams. All these apps were used to provide VR experiences to students.

Data analysis

For the test questionnaire, students were asked to score their agreement with statements on a Likert scale, ranging from strongly agree to disagree. The tests and questions did not solely focus on the user experience, but also how it related to the learning objectives and the three activities. When completing the questionnaire, participants wrote their comments by hand or typed them in online as a means to express their experiences after using VR. Open-ended inquiries were used as a statement to facilitate a more detailed response, which then compared to the questioner's information (Worley, 2015). In this research, open-ended questions were used to investigate students' experience with VR technology, its quality, and effects on learning. The responses were transformed to numerical values for the eight Likert-scale questions. They were combined with answers to open-ended questions to conduct a complete study of quantitative and qualitative data. Citations were added to unequivocal claims, minor spelling errors were rectified, and words were introduced in parenthesis when suitable for the explanation (Mays & Pope, 1995).

Findings and discussion

The effect of VR on student attitudes in polytechnic education when learning about robotic materials, steam power and numerous free-of-charge programs at Oculus Rift S was investigated using a questionnaire with eight items administered to 36 students. When the open-ended responses to the questions were tallied, key themes emerged, such as visual experiences and the educational benefits of virtual reality. The questionnaire was also used to examine the benefits of virtual reality in education. Figure 1 depicts the results of the three experiments, which focused on the perceived ease of use of immersive VR equipment. Students' ratings of the instrument's ease of use were used to determine the tool's overall effectiveness. Furthermore, students determined how readily and efficiently VR might be integrated into the learning process. Although the participants were voluntary, 30 responded to the questionnaire by strongly agreeing (84%), four responded agreeing (11%), and two responded neutrally agreeing (5%) that VR can be easily used in the classroom.

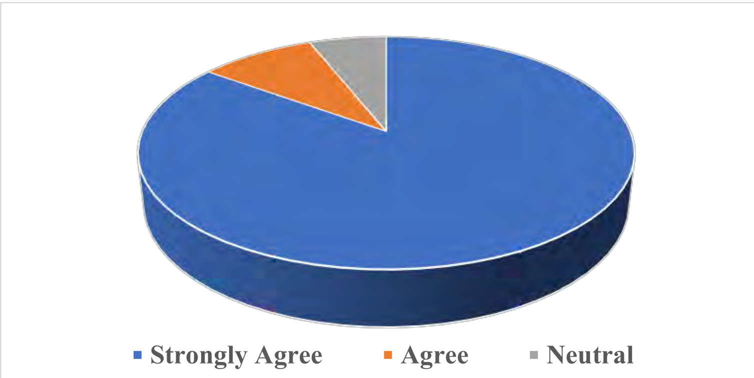

Figure 1. Percentage of student responses to questions about the ease of use of VR tools.

Students willingly participated in the survey, and 96% agreed that VR could improve student engagement and the learning experience when integrated with new learning media. Four percent indicated that it would not. Students' responses revealed three primary themes regarding their VR experiences: (1) students appreciated the learning process because it was exciting to play games, (2) students had a higher level of involvement in learning, and (3) the depiction of the material supplied was highly engaging.

VR offers students new ways to study by leveraging technology (Freitas & Neumann, 2009). Students can interact with items, allowing them to connect with what they see in VR, while expressing opinions, based on their perspectives. This aligns with Howard et al's (2017) findings that VR will become more popular as a means of enhancing students' active learning, and so that they can directly respond to the requirements of higher education.

VR in virtual fieldwork can encourage student participation in instructional goals (Graeske & Sjöberg, 2021). The findings from this study imply that a sensation of being *in the moment* in a virtual reality setting leads to more in-depth cognitive processing of the educational content (Figure 2).

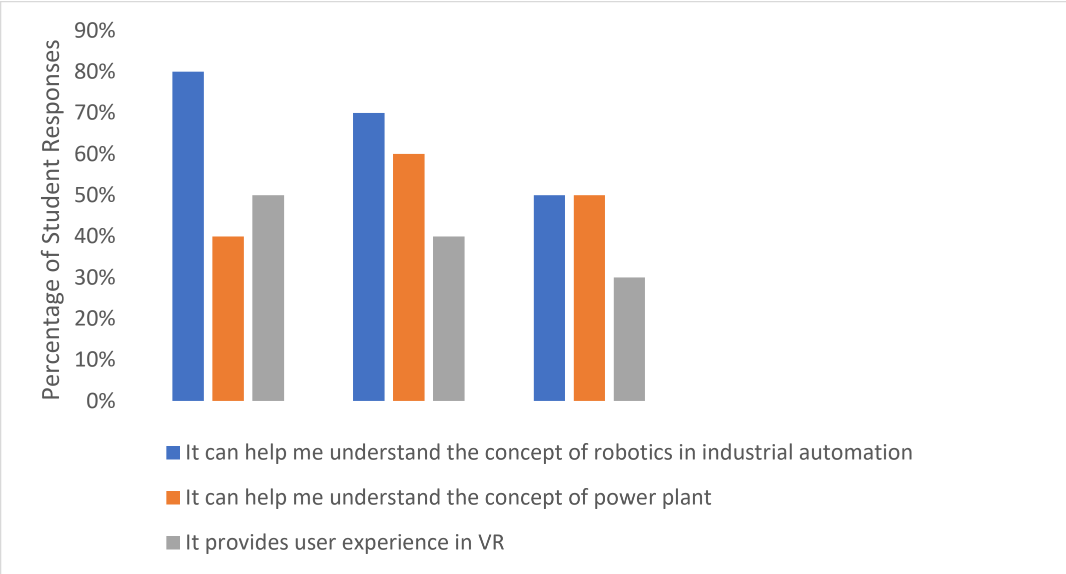

Figure 2. Students' assessments of VR's potential assist grasp of set learning percentage.

According to (Ai-Lim Lee et al., 2010), systems activate students' psychological responses to being present or in a created environment—using VR technology. The environment's unique characteristics and the representation and high level of human interaction or control provide the 3D environment with a sense of presence (Ugwitz et al., 2019; Voinov et al., 2018). VR provides clear, practical examples of extending and expanding work into the *actual* world, and there is an evident link between *interest* and *engagement* in the research findings (Lorenz et al., 2018). Even though immersive VR tools have been shown to boost student engagement, the findings of this study cannot be applied to all professions because they are not generalisable.

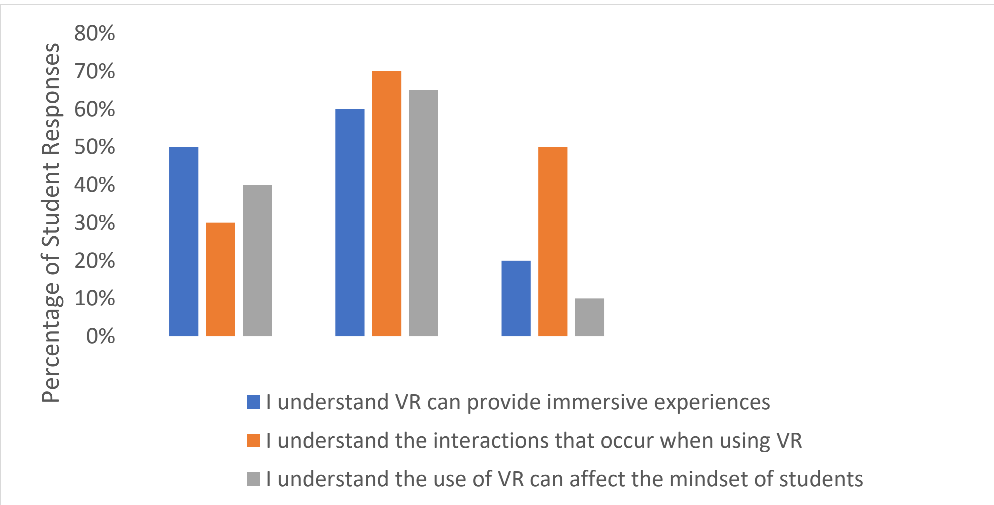

Figure 3. Students' perceptions of the tool's ability to improve knowledge of the learning objectives.

Students agreed that VR might boost their involvement in learning in vocational education (Figures 2 & 3). Figures 2 and 3 also illustrate that students are interested in robotic materials and power plants, as evidenced by their multiple uses of VR. The findings imply that in some contexts, immersive VR technology might lead to more student engagement. This study provides preliminary empirical evidence about the utility of immersive VR tools in enhancing student engagement in learning. The strong sense of presence associated with virtual reality to evaluate more robust student engagement and motivation, as well as deeper cognitive processing (Ai-Lim Lee et al., 2010), aligns with the discovery that *presence* as a psychological sensation is similar to being in a natural environment, except that the VR system creates the domain (Vidal, 1997). The visual depiction and high degree of engagement in VR give the impression of being in a 3D environment (Dalgarno et al., 2002; Dalgarno & Lee, 2010). The use of VR in vocational education, according to Stojšić et al., (2017), can build and expand the way students work because VR can mirror practical examples of work, in the actual world.

The competence to study through virtual media (cited in n=32 responses), increased work knowledge and comprehension (n=30 responses) are crucial findings to support the impact of increased interest and engagement (n=32 responses). Figure 4 outlines students' perceptions of VR.

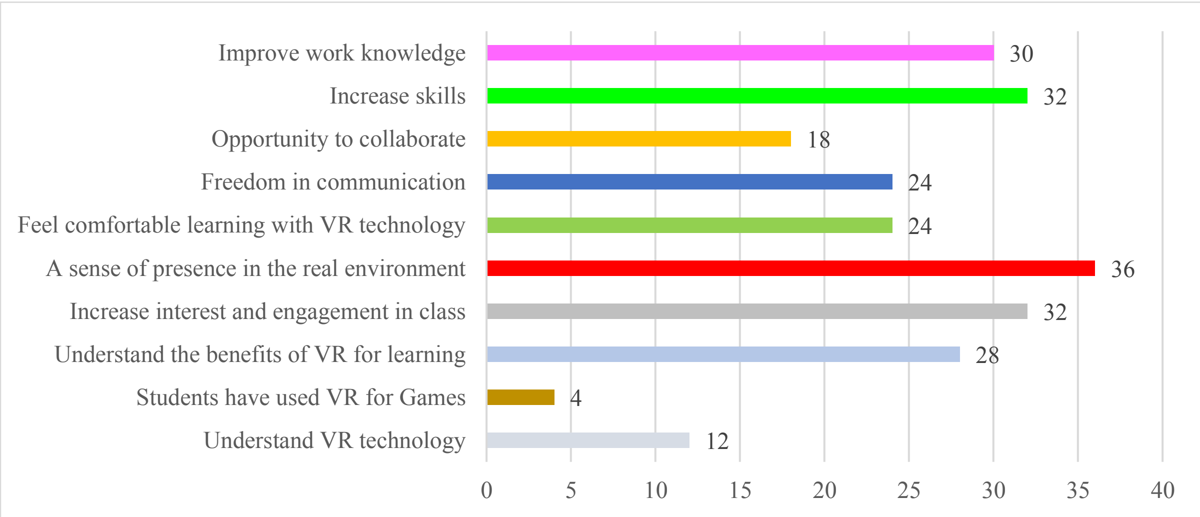

Figure 4. Students' perceptions of VR.

Students' reactions to the employment of VR technology are diverse (Figure 5). The idea that a high level of immersion is required to create engagement and realism in the immersive quality of the experience was countered by only 16 of the students, who reported feeling dizzy and disoriented after wearing VR headgear (Chang et al., 2020). Dizziness can be caused by low screen resolution, headsets, and headset changes (Cassani et al., 2020).

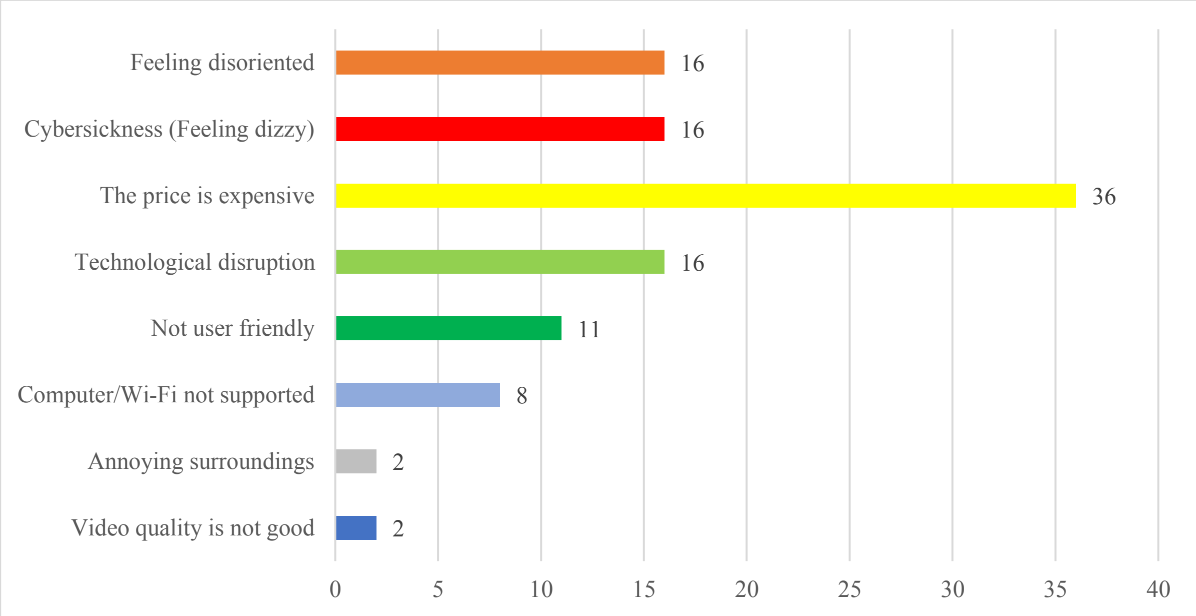

Figure 5. Students' perceptions of the quality and VR effects.

The headset's limited screen resolution was difficult but learning material (props) should not cause students to become dizzy and would need to be thoroughly studied for VR to become a more extensively utilised instructional tool in the future (Achuthan et al., 2020). A smaller horizontal field of view helps alleviate navigating dizziness by reducing control flexibility (Oh & Son, 2022; Rebenitsch & Owen, 2016).

According to our findings, prior preparation is required for optimal immersive VR learning. The efficient and safe use of immersive VR technology necessitates planning, training and continuing support from the whole teaching team. Before introducing tools, it is critical to analyse the goals and outcomes of learning in classes and practice, with devices being included if a reasonable expectation exists that they will help student involvement. It is also important to ensure adequate interactive educational spaces, where students can walk around, when considering VR technology.

After operating and training with VR systems, students obtained a better grasp and command of the notion of power plants and robotics for industry. Students comprehended the operating principles and work procedures of robots and power plants and processed the information offered by the VR system to assist them in carrying out various operations and accomplishing associated duties. The VR system helped students acquaint themselves with, and better grasp, the procedures and processing circumstances at different stages of robotic and power plant operations, by providing dual sensory feedback from visual immersion offered by VR and body movements.

The immersive VR experience deepened students' hands-on knowledge of electricity production at the power plant, allowing them to understand better and master particular production situations as if they had observed real-world scenarios. To learn the overall processing relationship, students could see the processing operations and operational state of the steam power components, including the boiler, turbine, and generator. Students demonstrated the processing scenario and machine state in the power plant and in relation to industrial robotics. They could correlate what was displayed in the VR system, through discussion with the lecturer, in terms of how a boiler engine was utilised in the preliminary procedure before the process in the turbine. In this case, panel representations of power plants and robotic systems are not only three-dimensional but also animated in VR systems. All machines can be portrayed in a dynamic condition based on their real-world surroundings and can be grouped into a complete process to show the machine's proper location. Students quickly mastered the actual sequence of operations using techniques and process states in the VR system with spatial comprehension. Students learned that electricity needs to be processed to determine the quantity of supply required until it is supplied to customers by recalling the state of processing in a VR system.

Experiments with robots provided a functioning description of the robot and its components, including the controller, actuator, sensor, and battery. After utilising VR, students also comprehended specific processing concepts and challenges that are generally perplexing or more difficult to understand. For example, in the previous session, students were frequently confused about the sequence of events that occurred while generating electricity at a power plant before distribution. This may be because usually lecturers only teach orally or with graphics found online for students to see in a classroom setting.

The procedure at the power plant can be taught entirely through presentations and flash movies rather than through realistic simulators. There appears a significant gap between school education and the real-world, preventing students from visualising the relationship between various equipment functions in the workplace. Students quickly grasped these concepts by interacting with the virtual operation of the VR system, which clarifies the relationship between pieces of robotic machines, power plants and processing programs.

There are various ways that VR technology can be used as a learning tool (Fowler, 2015). Students can interact in an authentic and realistic environment through Oculus Rift VR, which is backed by accompanying software, using today's VR technology. Students enter a VR environment that provides a sufficient visual representation of the actual world. However, several components of the natural environment, such as heat, temperature, and atmospheric conditions, are missing due to their difficulty in replication. The capacity to give learning data or analysis is the critical benefit of today's simulator suites. This information often comes in the form of hours of practice and graphs depicting the quality of the performance of VR participants. Learning analytics from VR simulators can provide students and instructors with feedback and information for further analysis when used appropriately (Chan, 2020). In general, VR technologies have a large and favourable impact on educational outcomes. With the rapid advancement of information technology, VR has gained a lot of traction in the field of education (Yu, 2020).

VR training systems are now commercially available in connection to the advancement of learning in vocational education. Storytelling has been demonstrated to be an effective way to communicate and aid in knowledge transfer for students. In vocational education, there has been a growing interest in adopting advanced technology such as VR to improve training and learning. The combination of storytelling talents with a comprehensive training system, on the other hand, is largely untapped. In recent years, the demand for cost-effective vocational training options has grown to improve the skill level of a country's population (Doolani et al., 2020). In the other research, VR duplicates real-world events and interactive operations in the classroom, which aids students' comprehension of realistic situations. Today's vocational furniture training is comfortable and familiar and should be altered to respond to the future and solve labour shortages, in response to the growth of many automated mechanical products (Lee, 2020).

If instructors, especially those in vocational education, intend to embrace virtual learning environments, they must be prepared to create interactive activities that stimulate student involvement. Student interactions in a VR environment that is well-designed has a favourable impact on learning engagement (Smutny, 2022). Virtual tours using video snippets and physical locations on the map could be one approach to such learning. It may be more successful to use gaming features to draw kids' attention and then supplement it with video viewing. However, according to one study (Checa & Bustillo, 2020), incorporating immersive VR into learning can increase student involvement, while not necessarily increasing knowledge levels. Users in a VR environment may be enthralled by the new surroundings and divert their attention away from the learning objectives.

With the usage of VR technology in education, the role of lecturers will change. The lecturer's responsibility in a VR environment will be to define the agenda, share knowledge, create an environment that encourages student participation, monitor, answer questions and evaluate. Lecturers who take on a new job as learning guides will have to adjust to a new, uncertain standing, and in some respects, they will become peers with their students. In a practical sense, the continued acceptance of VR should make it easier for them to adopt this new position. As lecturer duties change, they will become much more digitally informed and proficient, whether by choice or need. There will be some continuity from current teaching frictions around evaluation and resource allocation, and a few lecturers will be involved in designing new learning resources to play a more significant part in VR learning at this time.

Conclusion

This article has reported research, which explored polytechnic students' perceptions of the use of immersive VR technology in vocational higher education. The VR technology used in a virtual environment can substantially impact the user's field of view. Immersive VR is easy to use and increases student knowledge and participation in their learning. By exhibiting a comprehensive understanding of their field of research and accomplishing the distinct learning objectives of numerous classes, students can demonstrate a greater devotion to a particular area of learning. A sensation of presence associated with VR's high level of immersion was linked to improved learning and engagement. Future research into the learning outcomes of immersive VR technology in vocational higher education will occur, to extend this study.

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