# Perceptions of Virtual Reality as a Learning Tool in Electrical and Electronic Engineering

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**DOI: https://dx.doi.org/10.47772/IJRISS.2024.8110051**

**Received: 28 October 2024; Accepted: 04 November 2024; Published: 02 December 2024**

## ABSTRACT

This study explores the integration of Virtual Reality (VR) into Electrical and Electronic Engineering (EEE) education, focusing on enhancing student engagement through technology- enabled learning. Expanding on earlier research showcasing VR's effectiveness in various disciplines, this study examines its potential benefits for EEE students in Sri Lanka. Using a survey of EEE undergraduates from a Sri Lankan engineering institute, the study identifies the benefits, obstacles, and possible improvements associated with VR's implementation in the EEE curriculum. Results reveal that VR can significantly boost student engagement and deepen understanding compared to traditional learning methods. However, challenges such as health concerns, limited content availability, and financial constraints were identified as barriers to its widespread adoption. The paper concludes with targeted recommendations to address these challenges, aiming to support sustainable VR adoption and optimize its educational value in the Sri Lankan EEE context.

**Index Terms:** Virtual Reality (VR), Electrical and Electronic Engineering (EEE), Traditional Learning

## INTRODUCTION

Virtual Reality (VR) is a technology that creates a simulated, immersive environment that users can interact with in a seemingly real or physical way. It typically involves wearing a VR headset, which covers the eyes and sometimes ears, to fully immerse the user in the virtual environment. The headset displays a 3D computer-generated world that responds to the user's movements, creating the sensation of being inside this environment rather than just observing it on a screen. The current applications of VR span across diverse fields, including gaming, virtual tours, healthcare, education and training.

VR has emerged as a transformative tool in engineering education, providing immersive learning experiences and novel teaching approaches. Globally, VR has been acknowledged for its ability to increase comprehension, student performance, and educational expenses. Virtual Reality presents a novel approach by generating immersive and interactive settings that surpass the limitations of conventional education techniques. Students can study complex scientific phenomena in three dimensions by going on virtual explorations with VR. Through active interaction and experience learning, this immersive method not only engages students but also promotes a better knowledge of engineering subjects.

Despite these advantages, there is still a substantial lack in study into the specialized use of VR in Sri Lankan engineering institutes, notably in the fields of Electrical and Electronic Engineering. While the benefits of VR are extensively recognized in a variety of technical fields, its integration and influence in Sri Lankan educational system is yet to be explored.

This study aims to address this gap by gathering feedback from Sri Lankan electrical and electronic engineering undergraduates in a selected engineering institute on the adoption of VR in their coursework. By the students point of view, the study provides important insights into the practical implementation, problems, and advantages of integrating VR in Sri Lankan engineering institutions. Understanding the views of students can help in identifying the particular requirements and expectations of local engineering undergraduate

community, enabling development of VR integration techniques.

The paper is structured as follows: Section 2 discusses the global adoption of Virtual Reality (VR) across various engineering disciplines, providing insights into its diverse applications. Section 3 outlines the data collection process, detailing how responses were gathered and analyzed. Section 4 presents and discusses the results obtained from the study. Finally, Section 5 concludes the paper by summarizing the findings and offering recommendations for future research and implementation.

## LITERATURE REVIEW

The use of VR in engineering education has gained popularity over the years, with tremendous potential to improve learning experiences across several engineering disciplines. VR has become popular in engineering education for its capacity to increase students' comprehension, performance, and educational experience. One of the studies in literature [1], has examined VR's cognitive and pedagogical benefits, emphasizing its role in creating immersive learning environments that lower infrastructure costs and provide equal learning opportunities, particularly for students who have impairments. Drakatos *et al.* [2] underlined the capacity of virtual reality to improve student performance and grades while simultaneously 978-1-6654-0741-0/22/$31.00 ©2022 IEEE lowering educational expenditures and assuring an equal learning environment for all students. Another study discusses the development of interactive, immersive VR environments in engineering education at the University of Warwick, emphasizing the long-term benefits of incorporating VR into the curriculum [3].

In the literature, VR has been used in Chemical and Biochemical Engineering to comply with educational and training requirements. In [4] authors have investigated the use of VR in chemical and biochemical engineering education, with an emphasis on technology, pedagogy, and socioeconomic implications. The authors emphasize the significance of creating unique educational impact evaluation approaches to evaluate VR's performance in various sectors. Another research contributes to this by describing the use of VR in chemical engineering education, covering applications such as virtual chemical plants, laboratory safety simulations, and virtual campus tours. These immersive technologies not only increase student engagement, but also give hands-on experience in a safe virtual environment [5].

VR has also been used as an effective teaching tool in Biomedical Engineering. A study done by Singh [6] has investigated the use of VR in biomedical engineering education, specifically to teach students in inter-professional partnerships in hospital settings. According to this study, VR provides an immersive environment in which students may practice difficult medical procedures, improving their practical abilities and comprehension of biological principles.

VR is used in Production Engineering to better comprehend production processes and Industry 4.0 ideas. One of the studies presents a knowledge engineering strategy for developing successful and adaptable VR applications in industrial engineering, backed up by relevant case studies [7]. In another study, authors discuss on how virtual reality was used to teach students about Industry 4.0 and Re-configurable Manufacturing Systems (RMS). Further, they underline the importance of VR in providing immersive experiences that help students understand complicated industrial ideas effectively [8].

Virtual Reality Learning Environments (VRLEs) have also been used in the field of Materials Engineering to improve student results. In a recent research, engineering students used both newly designed and existing VRLEs, as well as a set of VRLEs that had been built in the past. The design procedures for both sets of VRLEs are thoroughly described in the study. Notably, 103 students' survey responses indicate that employing a step-by-step procedure approach helped them retain more of the information they learned, as seen by their better comprehension even a year after they started using the VRLE [9].

Civil and Construction Engineering has also benefited from the application of VR technologies. A study done by Vergara [10] has gone deeper into the architecture of VR learning environments in engineering, providing a basic flowchart for designing VR applications that can be used across several engineering disciplines. Additionally, Bohne has researched on creating VR environments to improve human performance and learning outcomes when compared to traditional learning methods [11]. Another study has supported this by

investigating the use of VR in project-based learning and establishing its favorable influence on course results, communication, and problem-solving abilities [12]. In [13] researchers have ad- dressed the use of virtual reality models to visualize and mimic the construction process. Their research demonstrated how VR models allow students to see the actual progress of construction projects, follow planned sequences, and visualize the shape and details of each component involved. Furthermore, these models facilitate the study of equipment operating procedures, making them useful instructional aids in civil engineering courses.

In Automotive Engineering, VR has been used to develop immersive learning experiences for students. Literature reports the development of a VR application designed for automotive engineering students. This application intends to provide practical, hands-on experience in a virtual environment, in line with the concepts of Education 4.0. The authors emphasize the potential of VR to improve automotive engineering education by providing students with an immersive and engaging learning experience [14].

In the discipline of Software Engineering, VR is being investigated for its potential to improve coding and software development techniques. Literature explores the capabilities and uses of VR in this software engineering, particularly for live coding and code review. The authors also discuss future obstacles and open topics in the field, highlighting the importance of more study to fully fulfill VR's promise in software engineering education [15].

The practical application of virtual reality in teaching is a key focus in mechanical, electrical, and computer science engineering. Previous studies provide a realistic course design for VR in engineering education that emphasizes multidisciplinary projects and the development of important engineering skills [16]. Another study presents a VR platform designed to improve learning through immersive experiments, which emphasizes the potential of VR to enhance electrical engineering education even further. This platform, which uses the Wirefusion® software and the VEMA platform, illustrates the potential of virtual reality to deliver interesting and effective learning experiences for electrical engineering students [17].

Despite the benefits of VR in engineering education, there is a significant lack of understanding about how these benefits might be utilized in the Sri Lankan context, particularly in electrical and electronic engineering. Existing research broadly discusses VR's potential to improve learning, but it does not address the practical deployment and usefulness of VR in Sri Lankan engineering education. This gap is crucial because it leaves open concerns regarding the potential impact of VR on student learning outcomes, engagement, and retention in Sri Lankan engineering programs.

To address this gap, the research focuses on collecting feedback from EEE undergraduates at a Sri Lankan engineering institute regarding their perspectives on VR. By directly engaging with the students, the study aims to identify practical challenges, perceived benefits, and potential barriers to VR adoption within their learning environments. Additionally, the study investigates the students' opinions on the potential im- pact of VR on their learning experience, including factors like motivation, engagement, and practical exposure. By gathering this valuable feedback, the research aims to provide insights on development and implementation of effective VR-based learning strategies in Sri Lankan engineering education.

## METHODOLOGY AND RESULTS

This study employed a qualitative research methodology to explore the perceptions of a group of undergraduates at an Engineering Institute Malabe, Sri Lanka regarding the potential of VR in learning Electrical and Electronic Engineering. The study involved Electrical and Electronic Engineering undergraduates of different undergraduate years to ensure an extensive understanding of the potential impact of VR on engineering education. By surveying the students in the 3rd and 4th year of their engineering degree, the study collects a diverse range of viewpoints on VR's effectiveness and application.

A total of 30 EEE undergraduates participated in the survey where 15 were male and other 15 were female. Meta Quest 2 was used as the VR device for the experiment and it is shown in Fig. 1. Table 1 shows the distribution of the study year among undergraduates in the Department of Electrical and Electronic Engineering


Fig. 1: Meta Quest 2

Before the data collection began, all the participants received a brief introduction to the VR kit and its functionalities. Following this, they were given the task of joining a laboratory class experience through the VR kit. The 360 video was based on the introduction to actuators and sensors.

A questionnaire was shared after, to gather their perspectives on VR as a learning tool. The questionnaire is structured into four sections. The first section gathers information on participants' prior experience with learning with VR. The second section explores how the students feel about conducting a lab practical through VR. The third section questions participants

Table I Participants distribution in undergraduate years

| | 3rd Year | 4th Year |
|---|---|---|
| Male | 7 | 8 |
| Female | 8 | 7 |

to compare VR with traditional teaching methods. Finally, the fourth section addresses the positive and negative aspects of implementing VR in Electrical and Electronic Engineering education.

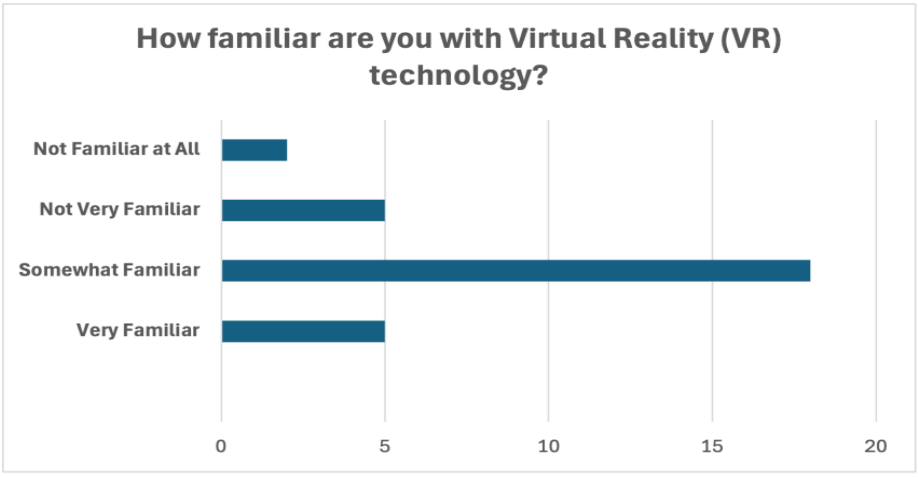


Fig. 2: Information on participants' previous VR experiences

The familiarity of the participants with virtual reality (VR) technology was found out to be as in Fig. 2.

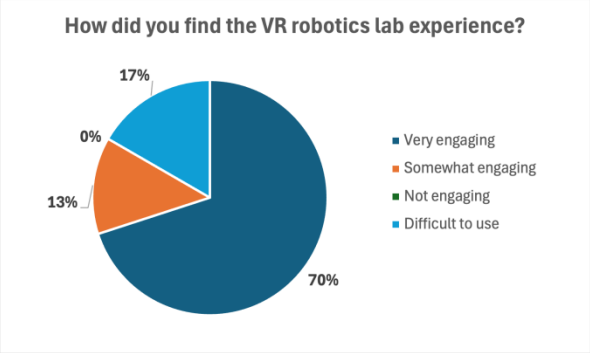


Fig. 3: VR Lab class experience

Fig. 3 shows the students responses on how engaging the lab practical experience through the VR box whereas in Fig. 4 it shows how far they understood what was taught in the lab class. Fig. 5 highlights the positive aspects of using VR for learning, as perceived by the students. Fig. 6 presents the negative aspects identified by the participants.

To gain insights into the students' perspective on VR technology implementation in EEE teaching, they were asked to rate their experience compared to traditional teaching methods. Fig. 7 summarizes the responses thus obtained.


Fig. 4: Understanding of the lesson after the experience

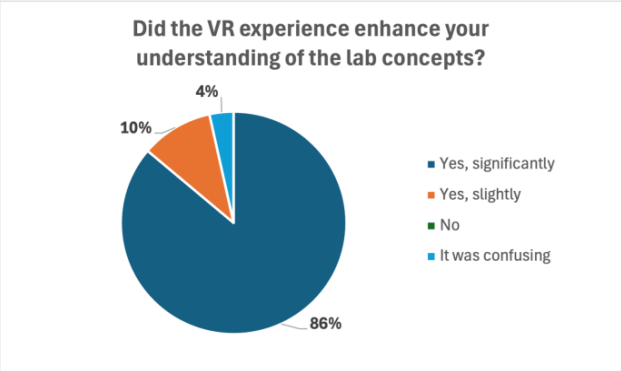


Fig. 5: Positive aspects of using VR for learning

## DISCUSSION

In this study, out of 30 EEE undergraduates, 15 were male and 15 were female. It was observed that apart from 2 participants all had previous experience with VR but with different exposure levels. Participants with prior VR experi- ence primarily used it for gaming and simulation purposes but not for any academic purposes.

After the individual VR experience in the robotics lab class, around 80% found the lab class very engaging. It is important to note that none of the students found the class not engaging. This shows that the students were

very interested in experimenting with the VR kit.

Regarding the understanding of the things they learned in the lab class, 86% were significantly happy with the content they learned. However, 4% of participants found the lab class conducted through the VR kit confusing. This could be due to the new experience of learning a lab class via a virtual tool rather than the traditional hands-on experience they receive in a physical lab environment.

When considering the positive aspects of VR in teaching, the higher number of respondents mentioned that student engagement and interest could be enhanced by implementing VR. Additionally, it was noted that students' visualization skills during laboratory sessions could be improved through integration of VR. This highlights the potential for VR to not only make learning more interactive but also to foster deeper comprehension and retention of complex concepts.

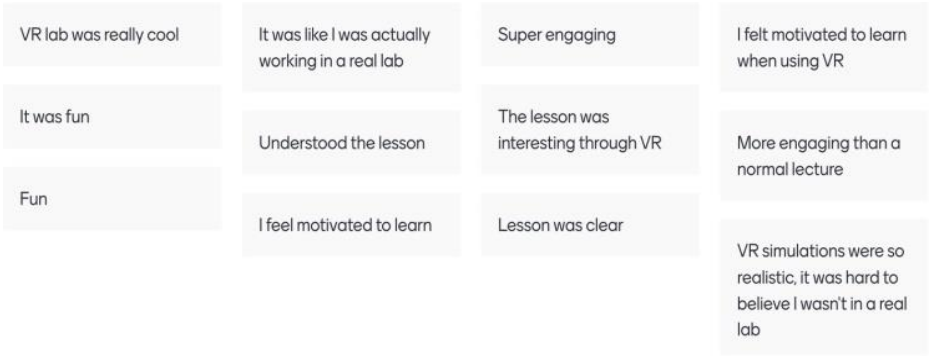


Fig. 6: Negative aspects of using VR for learning

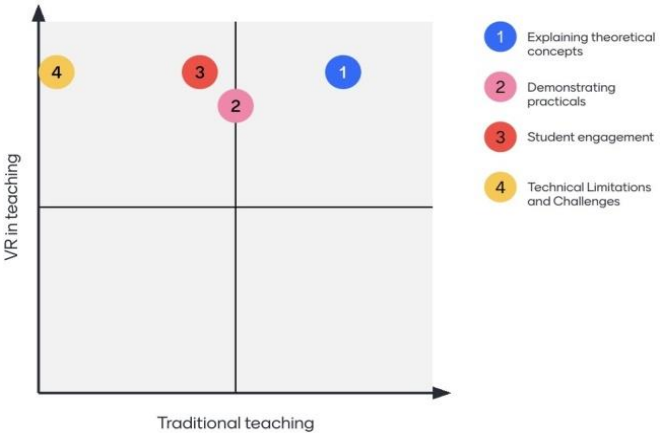


Fig. 7: Comparison of VR with traditional teaching methods

Despite the multiple advantages of implementing VR, some concerns and challenges were also found out from the study. Health-related problems were a common issue that the participants faced. Headaches, eye strain, dizziness were some of the health-related issues listed. Some students found the resolution of the video not up to a high standard thus making them uncomfortable. Even the Meta Quest 2 has full HD resolution due to poor internet connectivity the quality of the video will always not be consistent. Thus it is important to have proper internet connectivity when experimenting with VR to avoid vision problems. Also, the difficulties in wearing the VR kit for a long time were also highlighted. Having a weight of half a kilogram, it is realistic that some students may find it difficult to wear for a longer period of time. Another negative aspect of VR was observed to be unfamiliarity with the VR tool kit. Even though the students had previous experience with a VR kit, the handling techniques may differ from version to version thus the students could have faced difficulties in navigating through the platform.

In the large-scale implementation of VR in teaching, another limitation that could arise is the high cost of VR kits. With a limited number of kits, the time consumption to conduct a lesson to a large class would be very unlikely and will not be time efficient. Thus, the institutes may have to look for funds to accommodate enough

VR kits if they have a plan to implement VR in teaching. Specially in the Sri Lankan context, a long- term plan should be executed in order to implement VR in universities. However, there is a possibility for the private institutes to adopt to the VR teaching culture, but a much longer time will be required by the government educational institutes to establish VR as a learning tool.

Also another limitation found of the lack of high-quality VR content for Electrical and Electronic Engineering teaching. As creating the required animations would take additional time and cost, it is necessary to plan accordingly and prepare the content prior to promoting teaching through VR. Addressing these concerns is crucial to ensure that VR remains an inclusive and accessible tool for all students.

When comparing VR technology with traditional teaching methods, the study revealed that the students are comfortable with both traditional way of teaching and VR in teaching equally at a higher rate as shown in Fig. 7. However, they believed that they could get more advantages if they have the lab classes through VR rather than traditional way of having lab classes. With respect to the student engagement, the VR in teaching received a higher number of preferences. This closely aligns with existing research, which suggests that integrating VR into a learning environment can significantly boost student motivation and engagement.

Despite encountering challenges such as technical limitations and physical discomfort, the participants overwhelmingly expressed enthusiasm for VR-based learning. This positive reception indicates a strong potential for VR to revolutionize engineering education.

To fully harness this potential, universities can invest in high-quality equipment and prioritize regular maintenance. Faculty development through VR training and content creation workshops can further enhance the learning experience. Finally, fostering collaboration between faculty and researchers can lead to innovative, accessible VR applications that optimize engineering education for Sri Lankan undergraduates.

## CONCLUSION

Adopting VR into Electrical and Electronic Engineering education presents both promising opportunities and notable challenges. The study revealed that VR technology can substantially enhance practical demonstrations and student engagement when compared to traditional techniques. With 60 percent of participants confirming VR's benefits in teaching Electrical and Electronic Engineering undergraduates, the technology has the potential to enhance visualization and interactive learning experiences. However, while VR provides benefits such as better student interest and engagement, it also results in certain issues. High implementation and maintenance costs, the demand for high-quality content, and possible concerns with internet connectivity and user comfort are all key obstacles that must be addressed. Additionally, incorporating VR into the existing curriculum requires significant time and effort.

In conclusion, despite the challenges, there is a strong inter- est in students incorporating VR into Electrical and Electronic Engineering learning. It is clear that VR has the potential to complement traditional teaching methods by offering immersive and interactive experiences that enhance learning. To maximize its effectiveness, careful consideration of the associated costs, content development, and integration into the curriculum will be essential.

Future research on VR in the teaching of Electrical and Electronic Engineering should focus on creating excellent subject-specific VR material, evaluating the long-term effects of VR on student learning and engagement, and cost effectiveness of VR systems. Effective ways to incorporate VR into current curriculum and handle accessibility and user experience concerns should also be investigated in future studies.

## ACKNOWLEDGMENT

The authors sincerely appreciate the participated under- graduates form the Department of Electrical and Electronic Engineering of the selected institute for their significant con- tributions to this study. Their involvement and insights were crucial in achieving a thorough understanding of the potential benefits and challenges associated with incorporating Virtual Reality (VR) into the teaching of electrical and electronic

engineering.

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