Perception on the Use of Virtual Reality (VR) for Science Subjects in Primary School: A Systematic Literature Review

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ABSTRACT

This systematic review, conducted according to PRISMA guidelines, investigated the impact of various educational platforms on learner motivation. The study analyzed 20 research articles published between 2020 and 2024, focusing on the utilization of Virtual Reality (VR) technology in education. Key findings revealed that VR offers significant benefits, including the provision of realistic simulations that enhance visual learning and concept retention. Furthermore, VR promotes hands-on learning experiences, fostering the development of essential 21st-century skills such as practical skills and problem-solving abilities. While VR demonstrates the potential to significantly improve learner engagement and motivation, the study also acknowledged the challenges associated with implementing VR technology in educational settings. This review serves as a valuable resource for educators seeking to effectively integrate VR into their teaching practices, ultimately improving student learning outcomes.

Keywords: systematic literature review, Virtual Reality (VR) technology, Primary Education, Science Subject

INTRODUCTION

Education is one of the most crucial elements in the development of a nation. It is a systematic and organized process aimed at developing the knowledge, skills, values, attitudes, and potential of individuals to prepare them for life. Education involves a learning and teaching process that entails interaction between teachers and students, as well as structured learning experiences within an educational environment. Classroom teaching and learning involve the acquisition of new knowledge and skills for the benefit of students, as well as the retention of existing knowledge and skills.

The title "Perception on the Use of Virtual Reality (VR) for Science Subjects in Primary School: A Systematic Literature Review" was chosen to emphasize the critical role of teacher perceptions in the successful integration of VR technology in primary science education. Many studies have highlighted the need to bridge the gap between teacher perceptions and actual classroom implementation of VR. By focusing on teacher perceptions, this study aims to investigate their attitudes, beliefs, and concerns regarding the use of VR in science teaching. This focus will provide valuable insights into the factors that influence teacher adoption of VR and will inform the development of effective strategies for supporting VR integration in primary science classrooms.

The primary objective of the National Education Philosophy is to create individuals who are intellectually, spiritually, emotionally, and physically balanced and harmonious, based on faith and adherence to God. In this increasingly advanced and sophisticated digital era, Information and Communication Technology (ICT) plays an important role in various fields, including education. Many innovations have been developed within ICT, such as Augmented Reality (AR), Artificial Intelligence (AI), and Text-to-Image generations, with Virtual Reality (VR) emerging as a particularly promising tool. One of the latest innovations in ICT that has gained more attention is Virtual Reality (VR). VR is a technology where users can interact with a simulated three-

dimensional environment designed to provide an immersive experience. According to a study by Merchant et al. (2020), VR has immense potential to enhance the learning process and facilitate education by providing a deeper and more engaging learning experience in line with 21st-century education.

The Malaysian Education Blueprint 2013-2025 (MEB) outlines a comprehensive framework for transforming Malaysia's education system, emphasizing eleven key elements for achieving excellence. Among these, the seventh element underscores the vital role of Information and Communications Technology (ICT) in enhancing the quality of Malaysian education. This emphasis on ICT aligns perfectly with the demands of 21st-century education, where technology integration is no longer an option but a necessity

Research Objectives

The objectives of this research were:

1. To identify and discuss the perceived benefits and challenges faced by teachers when using VR technology in science education in primary schools.

2. To summerise how the use of VR influences teaching methodologies, student engagement, and learning outcomes in science subjects as perceived by educators.

Research Questions

The research questions of this study were:

1. What are the perceived benefits and challenges reported by teachers regarding the integration of Virtual Reality (VR) technology in science education within primary schools?

2. How does the use of Virtual Reality (VR) technology impact teaching methodologies, student engagement, and learning outcomes in science subjects in primary schools, as perceived by educators?

BACKGROUND OF THE STUDY

Virtual Reality (VR)

According to the book *The Silicon Mirage* (1992), Virtual Reality (VR) is a method by which humans visualize, imagine, and interact with complex computers and data. VR technology was introduced in the mid-20th century. According to Kuna, Alena, and Lubos (2023), teachers are no longer confined to the physical classroom space. Virtual Reality allows for virtual exploration of the world, while Augmented Reality enriches abstract concepts and enables teachers to guide students through 360-degree views and 3D objects. Such systems can also introduce students to interesting locations and artifacts. If students are empowered to visualize information in new ways, their ability to retain that information can be positively influenced. In the evolution towards Industry 4.0, the use of VR can become an alternative learning medium in this industrial era (Zulfikasari, Wardi, and Wahyu, 2021).

Benefits of Using Virtual Reality in Teaching

Virtual Reality (VR) has emerged as a powerful tool with the potential development in education. By immersing learners in simulated environments, VR offers unique opportunities for engaging and interactive learning experiences that go beyond traditional classroom settings. This literature review will explore the key benefits of using VR in teaching, focusing on its impact on student engagement, knowledge acquisition, and overall learning outcomes. Based on the literature studies there are many benefits in using VR technology ont only in education but can be used for students studying in other field too. According to Hasmiza, Nubli, Rashid, and Ropizam (2023), learning interest is a key component that motivates individuals to continue efforts to understand and learn something, ultimately determining students' success and achievement. The formation of this interest is influenced by various factors such as teachers, peers, the learning environment, and learning objectives. Farshad and Davoudi (2021) highlight the potential of VR to enhance student engagement

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and improve concept retention, particularly in science education. Teachers perceive VR as a valuable tool for making abstract concepts more tangible and interactive, leading to improved learning for students. However, successful VR implementation in the classroom necessitates proper teacher training to fully utilize the benefits of VR in educational practice. *Picture 1* shows the Uses of VR in classrooms.

Picture 1 The Uses of VR in classrooms for Science Subject.

Picture taken from https://virtualspeech.com/blog/how-virtual-reality-can-improve-online-learning

Furthermore, Fuqiang Qiu and Yinhui Hao (2024) found that VR can significantly improve student performance in language acquisition. By utilizing VR technology, educators can enhance language learning experiences, increase student engagement, and facilitate more effective language proficiency assessments. Kamil and Bayraktar (2024) emphasized that VR provides students with immersive learning experiences. VR can transport learners to different places and times, offering them firsthand experiences that would otherwise be impossible or impractical. Not only does VR motivate students to explore more, but it also improves their understanding and retention of complex concepts more easily

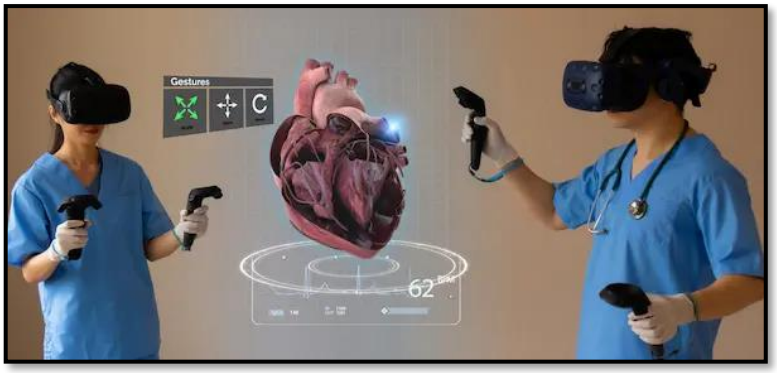
In addition to teaching, engineering education is also incorporating VR technology into its curricula. According to Arif, Bruri, Wahyu, and Pipit Anggraeni (2024), the increasing potential of Virtual Reality is enhancing Engineering Education (EE) and improving student learning outcomes, despite its limited current use in educational settings. Farheen, Madani, Faisal, Alotaibi, et al. (2024) reported a high impact of VR technology on Engineering Education, specifically in optimizing Manufacturing Sustainability, where learning outcomes increased by 25% in post-test scores. This evidence demonstrates the positive impact of VR technology on education. Picture 2 shows the uses of VR in engineering education.

Picture 2 The Uses of VR in Engineering Education.

Picture taken from https://www.ixrlabs.com/blog/virtual-reality-in-engineering-education/

Virtual reality technology has revolutionized the medical field by enhancing both education and patient care. In medical training, VR provides immersive simulations for complex procedures, allowing students to practice

in a risk-free environment. Based on the findings of Youssef, Algarni, et al. (2024), VR simulators enhance the overall learning abilities of dental students, enabling them to practice in a care-free environment. The studies also indicate that VR simulators cannot fully replace traditional training methods but can effectively complement them, enabling students to gain a deeper understanding and improve their engagement. Moreover, Christian, Lindwedel, Michaela, et al. (2021) explain that VR offers an immersive experience for learning complex tasks in nursing courses, providing procedural skills training to improve technical knowledge and proficiency in the medical industry. VR will make medical students more engaged in immersive and realistic experiences. Picture 3 shows the uses in Medical Education.



Picture 3 The Uses of VR in Medical Education.

Picture taken from https://healthcarebusinessclub.com/articles/healthcare-provider/technology/pros-cons-of-virtual-reality-vr-in-medical-education-training/

METHODOLOGY

This systematic literature review adopted the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 checklist as a guide. Following the 27-item checklist and a four-phase flow diagram, articles were analysed and evaluated to answer two research questions. The four phases of the PRISMA methodology were including identification phase, screening phase, eligibility phase, and inclusion phase

Phase 1: Identification Phase

In this study, there were five predefined criteria taken into account when identifying and choosing the articles. Firstly, the databases used to find suitable articles to be included in this systematic literature review were ScienceDirect, ERIC, Malaysian Journal Of Social Sciences And Humanities (MJSSM), Google Scholar, SCOPUS and PubMed. These six databases were accessible for the researchers and contain articles related to the field of education, social sciences, humanities and technologies. Secondly, these articles must be published between the year 2020 to 2024. The only type of documents chosen in this study was research article as the fourth criterion, and having a full, open access was the fifth predefined criterion for the articles to be chosen in this research. Total 80 articles were identify based on the titles. Table 1 shows all six criteria that were taken into consideration in identifying the articles.

Table 1 Table shows the inclusion and exclusion criteria in choosing the articles.

Criteria	Inclusion	Exclusion
Database	ScienceDirect, ERIC, MJSSM, SCOPUS and PubMed	Other databases
Publication year	2024	Articles before 2024

Language	English or Malay	Articles written in English and Malay
Document type	Research articles	Books, book chapters, literature review papers, seminar papers
Access to full text	Open access	Limited or no access
Keywords that used in articles	Virtual reality, Education, science Subject, Impact	Other keyword

Apart from the six predefined criteria, the articles were determined by using several search strings and keywords. Each search string was used in all three databases to find relevant articles related to the impacts of using VR technology in education precisely in science subject for Primary educations.

Search strings

Table 2 Table shows the search strings used in all three databases to identify the articles.

Teacher's Perception	AND	Virtual reality		
Impact	AND	Virtual Reality	AND	Education
The aplication	AND	Virtual Reality	AND	Education

Based on the criteria and the search strings in Table 1 and 2, all articles identified that fit the inclusion and exclusion criteria were chosen and listed, while others were removed and discarded from the list.

Phase II: Screening Phase

After a preliminary title screening from Phase I to ensure keywords matched, a more detailed abstract review was conducted using predefined inclusion and exclusion criteria. This process eliminated irrelevant articles and removed duplicates across all three databases, resulting in a more focused list. Out of 80 articles 20 articles were removed in screening phase where the keywords and abstract didn't meet the criteria.

Phase III: Eligibility Phase

After the screening phase, the remaining articles underwent a more in-depth analysis of their abstracts. Each abstract was thoroughly reviewed against a predefined set of **inclusion criteria** and **exclusion criteria**. Inclusion criteria are specific conditions an article must meet to be relevant. For example, an inclusion criterion might be "studies must investigate primary school teachers' perceptions of VR in science education." Exclusion criteria, on the other hand, define characteristics that automatically disqualify an article. This could include studies focused on secondary schools, different technologies, or published before a certain date. This phase was crucial to ensure all articles identified were relevant in answering the research questions. Out of 60 articles 40 articles were selected in this phase.

Phase IV: Exclusion Phase

Following the initial search, a rigorous selection process was implemented to identify the most relevant articles for analysis. Articles were evaluated based on predefined criteria designed to ensure a direct connection to the research question. This criteria included, but was not limited to, publication type (excluding books, book chapters, literature reviews, seminar papers), accessibility of full text, and publication date from the year 2020 to 2024. Articles that didn't meet these criteria were excluded from further analysis

The final number of articles selected after the four-phase screening process was 20. These articles consisted of research papers that employed qualitative, quantitative, mixed methodology and case study. 5 article utilised

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the qualitative method, 8 articles applied the quantitative method, 6 articles used mixed-method while the remaining 1 article were identified as Case Study research, as depicted in Table 3.

Table 3 Table shows the number of articles based on the research methodology employed.

Research methodology	Quantity
Qualitative	5
Quantitative	8
Mixed	6
Case Study	1

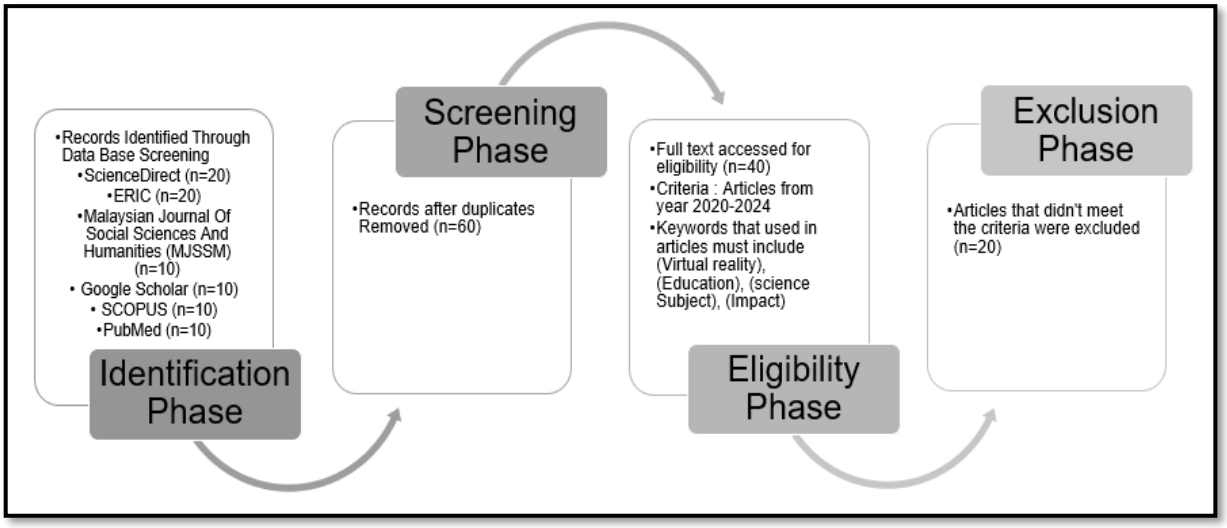

Figure 1 PRISMA Flowchart. The PRISMA flow diagram for the systematic review detailing the database searches, the number of abstracts screened and the full texts retrieved.

FINDINGS AND DISCUSSIONS

A total of 20 articles have been collected, analysed, and tabulated for the researchers' investigation. Notably, all articles were sourced from the period between year 2020 to 2024. This selection strategy was intended to validate the relevance of the current study by aligning it with recent issues and technologies. Additionally, it serves as a guide for the researcher in addressing the proposed research questions effectively. Table 4 summarised the type of research methodology used by each article, country that taken place to collect data the findings from the articles, research gap and also conclusion where all the findings are coded.

Virtual Reality technology has emerged as a powerful tool in primary education, offering **immersive and realistic experiences** that engage learners in ways where traditional methods cannot do. VR provides opportunities for exploration, experimentation, and discovery, enabling students to **interact with virtual environments and simulate real-life scenarios**. This hands-on approach fosters practical skills and **enhances problem-solving abilities**, preparing students for future challenges in a dynamic and digital-driven world. Based Farhana and Noor Azah (2021) stated that Fully-Immersed VR technology is multi-sensory, allowing users to interact with virtual environments in various ways. VR also enables the creation and visualization of objects and situations that do not exist in physical form in the real world.

Teachers' knowledge, attitudes, and skills in utilizing digital learning applications, including VR, are reported to be high. However, effective integration into the curriculum remains a challenge, emphasizing the need for **robust technical support** and alignment with educational goals. Teachers play a crucial role in this process,

requiring adequate **training to fully utilize VR's** potential to **improve student engagement** and concept retention. Educational outcomes are positively impacted by VR, as evidenced by improved student performance metrics and language acquisition. The technology facilitates interactive and immersive learning experiences that **enhance visual learning** and deepen conceptual understanding. This suggests that VR not only enhances traditional teaching methods but also supports differentiated instruction and personalized learning experiences tailored to individual student needs. Including VR as a tool of teaching it **improves students motivation** level to explore more about what they learnt and VR also **improved knowledge retention** of students where they easily understand complex subjects or notes.

Despite its benefits, challenges persist, particularly regarding infrastructure, technical support, and curriculum adaptation. Teachers express a preference for maintaining a balance between student-centered and teacher-centered approaches, integrating VR as a supplement to traditional teaching methods rather than replacing them entirely. This approach ensures that educational objectives are met while harnessing the innovative potential of VR to **enhance learning outcomes**. This statement is supported by Noraazian et al. (2020) in this article examined that the readiness level of teachers in using Multimedia Technology (MT) in PdP is moderately high, but needs to be **strengthened in terms of teachers' knowledge and skills** where educators **needs proper training** and resources to effectively implement VR in classroom teaching.

World Population Review (2024) has published a ranking list of countries based on the ICT Development Index (IDI) Score. Although Malaysia ranks 17th, compared to other developed countries, we still lag in using technologies in our daily lives, including in the education sector. Based on the reviewed articles, only a few surveys have been conducted in Malaysia to identify the uses of Virtual Reality in education. According to Amira, Thanaletchumi, Diviya, Khirtiga, et al. (2024), demographic factors, including age, teaching experience, and educational background, significantly influence teachers' perceptions of using digital tools in teaching. The study highlights the need for comprehensive training, institutional support, and equitable access to technology to maximize the benefits of digital integration in education based on 21st-century learning principles. Based on the reviewed articles, most surveys were conducted in urban areas, where most places are equipped with technology supplies. Some of the surveys were conducted in primary schools, secondary schools, and also in higher education institutions like universities. Although geographical factors where there is less technology usage or development in rural areas can affect usage of technology but, there is a necessity to improve school infrastructure, such as enhancing network connectivity and providing technology equipment for teaching. This will support teachers in utilizing these facilities more conveniently, not only in science subjects but also in other subjects. Teachers also need to equip themselves with ICT knowledge and skills and be prepared to use multiple technologies in the Pedagogical and Didactic Process (PdPC) to maximize the development of recovery students.

In conclusion, the findings underscore VR's significant role in modern education, offering a pathway to more effective and engaging learning environments. As educators continue to explore and integrate VR into classrooms, ongoing professional development and support will be critical to maximizing its potential. Acceptance and Use of VR Technology in Education: A Systematic Review by Noviantri and Sudiarta (2022). This review investigates the acceptance and use of VR technology in the educational context. The study's findings indicate that teachers' perceptions of the utility and effectiveness of VR play a crucial role in integrating this technology into teaching. By leveraging VR technology effectively, educators can enrich learning experiences, foster deeper student engagement, and better prepare learners for future academic and professional challenges.

CONCLUSION

The systematic literature review on the use of Virtual Reality (VR) for science subjects in primary schools reveals both promising benefits and significant challenges. VR technology offers substantial benefits by providing immersive and interactive learning experiences that engage students in exploring complex scientific concepts through simulated environments. This enhances visual learning, improves concept retention, and fosters practical skills and problem-solving abilities essential for future challenges.

However, integrating VR into primary school science education presents several challenges. These include the

high costs associated with acquiring and maintaining VR equipment, technical issues such as compatibility and connectivity, and the need for substantial teacher training and professional development to effectively leverage VR's educational potential. Moreover, curriculum alignment and the development of VR-specific educational content remain critical for ensuring that VR enhances rather than disrupts existing pedagogical practices.

Addressing these challenges requires collaborative efforts among educators, policymakers, and technology providers to establish sustainable support systems and infrastructure. Investing in ongoing research and development is essential to continuously assess the effectiveness of VR in improving student engagement and learning outcomes. By overcoming these challenges and maximizing the benefits of VR technology, primary schools can create innovative learning environments that prepare students for success in a technologically advanced world.

RECOMMENDATIONS

To effectively integrate Virtual Reality (VR) into primary school science education, it is recommended that educational institutions prioritize comprehensive teacher training programs. These programs should focus on enhancing teachers' technical proficiency in VR technology and their pedagogical skills for integrating VR into science curriculam. Additionally, schools should invest in robust technical support systems to ensure smooth implementation and operation of VR resources. Moreover, ongoing research and development efforts are crucial to continuously assess the impact of VR on student engagement, learning outcomes, and curriculum enhancement in primary science education. Based on the identified research gaps, future survey could focus on investigating the long-term impact of VR in science education for primary students, specifically examining its influence on student achievement, engagement, and motivation. There are few suggestions for future survey as shown below.

- Assess student learning outcomes in science subjects before, during, and after VR interventions
- Investigate how VR impacts students with diverse learning styles, including visual, auditory, and kinesthetic learners.
- Investigate the relationship between teacher training, access to resources, and the effective implementation of VR in science

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