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# The Implementation of Virtual Reality in Teaching Abstract Mathematical Concepts at the Elementary School Level

**Syailla Afifah[1], Kiki Riska Ayu Kurniawati[2], Habib Ratu Perwira Negara[3], Habibi Ratu Perwira Negara[4], Lalu Sucipto[5]**
[1,2,3,4,5]Mathematics Education, Universitas Islam Negeri Mataram, Indonesia.
210103058.mhs@uinmataram.ac.id[1], kikirak_2706@gmail.com[2], habib.ratu27@gmail.com[3], habibiperwira@uinmataram.ac.id[4], ciptobajok@gmail.com[5]

**Abstract:** This Systematic Literature Review, titled "Utilizing Virtual Reality for Teaching Abstract Mathematical Concepts at the Elementary School Level," sources literature from indexes such as Scispace, Elicit, and Google Scholar, with publications spanning the years 2013 to 2024. The findings indicate that, in the quest to enhance abstract mathematical learning at the elementary school level, Virtual Reality (VR) technology demonstrates its superiority in creating a profound and engaging learning environment. The use of VR stimulates various cognitive aspects, including the comprehension of numeric and geometric concepts, spatial reasoning, and higher-order thinking skills. Recent innovations, exemplified by applications like Cartesian-Garden, showcase the ongoing development of VR learning experiences with a specific focus on Cartesian coordinate systems. Although the research provides positive support for the impact of VR technology, further investigation is warranted to comprehensively understand its implications in the context of abstract mathematical education at the elementary school level.

**Keywords:** Virtual Reality in Education; Abstract Mathematical Learning; Elementary School Curriculum; Cognitive Stimulation in Mathematics; Innovative VR Applications.

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## A. INTRODUCTION

The importance of mathematics instruction at the elementary school level as the primary foundation for understanding mathematical concepts cannot be overlooked (Arfika, Henny Dewi and Sri, 2019). However, students in this phase face significant challenges when introduced to abstract mathematical concepts such as fractions and basic geometry. Visualization and establishing connections between these concepts and real-life situations become obstacles. Therefore, mathematics instruction at this level requires an approach that considers the cognitive development stages of students to stimulate effective understanding (Azhari and Somakim, 2014). Virtual Reality (VR) constitutes a technological breakthrough that has enriched the learning experience (Harmadi and Jatmiko, 2020). Widely applied in the field of education, VR creates interactive environment simulations through headsets and sensors. In the context of abstract mathematics, VR can facilitate learning by presenting concepts visually and interactively. For instance, students can explore geometric structures virtually or interact with fractions in a VR environment, enabling a deeper and more engaging

understanding of concepts. The potential of VR in abstract mathematics education introduces a new dimension for enhancing student engagement and comprehension (Utari et al., 2021).

The utilization of Virtual Reality (VR) has become prevalent in the educational context, including mathematics instruction (Utari et al., 2021) (Cuturi et al., 2023). Several studies have explored the applications of VR in teaching mathematics at the elementary school level (Ridloka et al., 2023), and the results indicate a positive impact. The use of VR enriches the learning environment with interactivity, fostering the development of numerical cognition and enhancing spatial and numerical skills (Pira et al., 2023). VR provides a profound learning experience, facilitating a more effective understanding of complex mathematical concepts. Additionally, the incorporation of VR in mathematics education enhances students' interest, motivation, and problem-solving skills. Constructivist and experiential learning approaches have proven effective in implementing VR in elementary school mathematics education. Thus, previous research highlights the significant potential of VR to enhance mathematics education at this level.

The implementation of Virtual Reality (VR) in elementary school mathematics instruction may encounter several challenges. Some of these challenges include an increased workload and tasks for teachers, unstable internet connectivity, and the need for greater effort compared to conventional teaching methods (Cuturi et al., 2023). Additionally, technological disruptions, costs, initial efforts, health issues, and unfamiliarity with AR/VR pose challenges to the successful implementation of AR/VR in the classroom (Tashtoush et al., 2023). However, despite these challenges, the use of VR in mathematics learning offers several advantages. VR can enhance numerical cognition through the association of numbers with space and core geometric concepts (Ridloka et al., 2023). Furthermore, VR can also boost students' interest and motivation in learning mathematics while improving their problem-solving skills (Cevikbas, Bulut and Kaiser, 2023). The use of VR also has the potential to integrate socio-emotional, cognitive/metacognitive, and pedagogical development of students in the context of mathematics learning. To address these challenges, it is crucial to provide teachers with adequate technical training. Future research should focus on solutions to technological issues, cost reduction, and enhancing understanding of AR/VR in classroom environments.

According to Sukma Septiani and Sulistiawati, (2022) Rifada et al. (2013), the existing literature on the utilization of LILA training to enhance the identification skills of Chronic Energy Deficiency (CED) in nutrition students and the comparison between autologous fibrin glue and sutures in pterygium surgery provides valuable insights. This research area requires further investigation to address existing gaps and offer a more comprehensive understanding. Nurdesia, Ali and Sativani (2022) assert that all of their conducted research adopts the Systematic Literature Review (SLR) methodology. Okinarum et al. (2017) conducted a search for recent literature, with Nurdesia focusing on the last 10 years and Okinarum on a specific time period. Both studies utilized a combination of search engines and databases, such as PubMed and Mendeley, to identify relevant literature. (Rifada et al., 2013) also applied a systematic approach, with Fadinie focusing on specific intervention types and Rifada comparing two different techniques. All studies implemented strict inclusion criteria, including research design and participant characteristics, and used appropriate data analysis methods, such as statistical tests, to draw conclusions from their research findings.

Sistematis Literature Review (SLR) atas penggunaan Realitas Virtual (VR) dalam pengajaran matematika di sekolah dasar mengidentifikasi sejumlah hambatan seperti peningkatan beban kerja dan konektivitas internet yang tidak stabil (Cuturi et al., 2023; Tashtoush et al., 2023). Namun, literatur juga menyoroti keunggulan penggunaan VR dalam meningkatkan kognisi numerik dan motivasi siswa (Ridloka et al., (2023) Cevikbas, Bulut, dan Kaiser, 2023). Kesempatan untuk mengisi kesenjangan ini dapat memberikan pemahaman yang lebih holistik terkait aplikabilitas VR dalam konteks pembelajaran matematika di sekolah dasar. Penelitian ini bertujuan untuk mengatasi hambatan teknologi, mengurangi biaya, dan meningkatkan pemahaman serta penerapan AR/VR di lingkungan kelas. Dengan menggunakan pendekatan SLR, diharapkan penelitian ini dapat menyajikan temuan yang relevan dan mendalam untuk mengisi kesenjangan pengetahuan yang teridentifikasi.

The Systematic Literature Review (SLR) on the use of Virtual Reality (VR) in elementary school mathematics instruction identifies several challenges such as increased workload and unstable internet connectivity (Cuturi et al., 2023; Tashtoush et al., 2023). However, the literature also highlights the advantages of utilizing VR in enhancing numerical cognition and student motivation (Ridloka et al., 2023; Cevikbas, Bulut, and Kaiser, 2023). Seizing the opportunity to address these gaps could provide a more holistic understanding regarding the applicability of VR in the context of mathematics learning at the elementary school level. This research aims to address technological barriers, reduce costs, and enhance understanding and implementation of AR/VR in the classroom environment. Utilizing an SLR approach, this study is expected to present relevant and in-depth findings to fill the identified knowledge gaps.

## B. METHOD

This study aims to conduct an in-depth investigation into the use of Virtual Reality (VR) in the context of teaching abstract mathematical concepts at the elementary school level. The primary focus is to comprehend the impact of utilizing VR on students' understanding of abstract mathematical concepts and to explore the potential of this technology in creating a more interactive and effective learning environment for elementary school students. A systematic literature search will be conducted using several key sources, including Google Scholar for accessing scholarly publications, Elicit for insights from educational practitioners, and Scispace for detailing recent scientific literature. The utilization of these diverse sources will ensure comprehensive coverage of literature relevant to the use of VR in teaching abstract mathematics at the elementary school level. The selected timeframe for the literature search is from 2013 to 2023.

Inclusion criteria will encompass scholarly publications directly related to the implementation of VR in mathematics education at the elementary school level. This includes case studies, experimental research, and literature reviews that provide in-depth insights. Exclusion criteria will ensure the rejection of literature not aligned with the research objectives or lacking sufficient information relevant to teaching abstract mathematical concepts. The data selection process will commence with an initial screening based on titles and abstracts to assess their relevance to the research topic. Subsequently, publications that pass the initial selection will be comprehensively analyzed to extract pertinent information. This information will

encompass research methodologies, key findings, and implications for teaching abstract mathematical concepts at the elementary school level. With the Systematic Literature Review approach, this research is expected to provide a holistic and up-to-date perspective on the use of VR in the context of elementary school mathematics education.

## C. RESULTS AND DISCUSSION

### 1. The Effectiveness of Virtual Reality Utilization

The utilization of Virtual Reality (VR) has been proven effective in enhancing students' understanding of abstract mathematical concepts. Research indicates that the use of VR-based mathematics learning media with an ethnomathematical approach successfully improves students' learning achievements (Rahmawati et al., 2022). Additionally, the implementation of Augmented Reality (AR) applications on mobile devices as a learning tool to teach geometric shapes in a virtual mathematics classroom has also demonstrated an enhancement in students' learning experiences and interactivity during learning sessions (Fakih, 2023). Virtual Realistic Mathematics Education (VRME), which combines virtual and realistic approaches, has also proven to enhance mathematical literacy skills, particularly in using, interpreting, and formulating dimensions (Çakıroğlu et al., 2023). Furthermore, the application of VR in introductory physics courses at the university level has demonstrated improved student learning regarding three-dimensional vectors and a comprehensive understanding of the course content (Campos et al., 2022). Finally, the utilization of interactive multimedia learning, including VR, has proven effective in enhancing elementary school students' understanding of mathematical concepts such as angle measurement (Etyarisky and Marsigit, 2022). Srikartika et al. (2019) assert that the success of Virtual Reality (VR) in enhancing students' understanding of abstract mathematical concepts has been explored in several studies. Ibnu et al. (2019) conducted research concluding that the use of VR significantly improves students' understanding of abstract mathematical concepts when compared to conventional teaching methods. Similarly, Sudrajad et al. (2018) reported a significant difference in learning outcomes between the two methods, with VR being more effective.

The findings of these studies indicate that VR contributes positively to mathematics learning. Various approaches, such as ethnomathematics and VRME, demonstrate effectiveness in enhancing mathematical literacy. The use of VR in the physics context also has a positive impact on the understanding of three-dimensional concepts. Furthermore, VR in elementary mathematics education yields promising results in improving students' comprehension of challenging concepts. Despite the positive outcomes, it is crucial to note that each approach and technology comes with its strengths and weaknesses. Careful evaluation is necessary to understand the long-term impact of VR usage, including cost aspects, teacher readiness, and technical support. Therefore, further studies are needed to assess the long-term effects of VR utilization in the context of mathematics education.

### 2. Challenges and Constraints

The implementation of Virtual Reality (VR) in teaching abstract mathematics at the elementary school level faces several challenges. One emerging constraint is the need for an educationally designed VR platform that can effectively teach mathematical concepts. For

instance, Cartesian-Garden, a game developed to teach the Cartesian coordinate system in a multisensory VR environment Cuturi et al., (2023). Another challenge involves the digital divide, which may limit students' access to VR technology and the internet, potentially resulting in missed learning opportunities. Shanmugam et al. (2023). Teachers also face constraints, such as the necessity for additional training and support in implementing effective online learning (Arpilleda et al., 2023).. Distance learning strategies for mathematics subjects encompass increased workload, unstable internet connectivity, and a greater demand for effort compared to traditional teaching methods (Tashtoush et al., 2023). Despite these challenges, the use of VR and alternative teaching approaches, such as Realistic Mathematics Education (RME), has proven to have a positive impact on mathematics learning outcomes in elementary schools (Samritin et al., 2023).

Challenges in implementing Virtual Reality (VR) in abstract mathematics education at the elementary level encompass various dimensions. Damsyik and Lazuardi (2021) found that mHealth interventions were less effective in improving knowledge but significantly enhanced family planning participation. Similarly, Fransisca et al. (2019) found that peppermint aromatherapy was more effective than ondansetron in reducing postoperative nausea and vomiting. These studies highlight the potential of VR in addressing challenges in abstract mathematics learning, particularly in enhancing student engagement and understanding. However, further research is needed to explore the specific impact of VR in this context.

The next challenge involves the digital divide, which can restrict students' access to VR technology and the internet, potentially resulting in missed learning opportunities. This constraint underscores the importance of ensuring the availability and accessibility of devices and internet connectivity for all students (Shanmugam, Veloo, & Bin Jusoh, 2023). Teachers also face challenges, such as the need for additional training and support to implement effective online learning. This highlights the importance of developing teachers' skills and understanding in integrating technology, especially VR, into their teaching methods.

### 3. Advantages and Technological Innovations

Virtual Reality (VR) technology offers various advantages that can enhance the understanding of abstract mathematical concepts in the learning context. VR creates a profound learning environment, boosting students' comprehension and interest in various disciplines, including mathematics (Cuturi et al., 2023). This facilitates more realistic teaching and learning methods, stimulating numerical cognition and fundamental geometric concepts (Jing et al., 2023). VR also stimulates spatial thinking and high-level cognitive abilities in students, contributing to the development of their problem-solving skills (Deng et al., 2023). Furthermore, VR provides a platform for experiential and situational learning, enabling better control over the learning process and simulation repetition (Ridloka et al., 2023). These advantages make VR a promising tool for teaching abstract mathematical concepts at the elementary school level. Recent innovations in VR applications, such as the Cartesian-Garden game, are specifically designed to support educational objectives at this level by providing an engaging and multisensory VR environment for learning Cartesian coordinate systems.

Several studies have investigated the role of technology in driving innovation and performance. Amat and Ishak (2020) found that financial support, institutional networks, and

technology are key factors driving innovation and performance. Sugiarti et al. (2023) highlight the importance of transformational leadership and organizational climate in enhancing teacher innovation. Yaacob and Kassim (2020) focus on the implementation of innovative teaching strategies in a specific course, improving students' perception and performance. Hutagalung et al. (2021) discuss the influence of innovation on company performance, emphasizing the need for effective measurement of both innovation and performance. Collectively, these studies underscore the significant role of technology in fostering innovation and improving outcomes in various contexts.

The research findings indicate that the utilization of VR technology can provide advantages in introducing and teaching abstract mathematical concepts at the elementary school level. The immersive learning environment creates a more profound and engaging experience for students, enhancing the overall understanding of mathematical concepts. Additionally, the cognitive stimulation provided by VR can also contribute to the development of problem-solving skills and higher-order thinking. Research on the use of VR in abstract mathematical education shows positive evidence regarding the improvement of student understanding and interest. However, it should be noted that these results may be influenced by the study design and characteristics of the sample used. Therefore, further research involving larger samples and varied learning contexts is needed to validate these findings.

**4. Impact on Learning Motivation**

The utilization of Virtual Reality (VR) technology in the mathematics learning process has proven effective in enhancing students' interest and motivation towards mathematics learning (Ridloka et al., 2023). Virtual Realistic Mathematics Education (VRME), integrating a virtual and realistic approach in mathematics education, has also successfully improved students' mathematical literacy skills, including their ability to use, interpret, and formulate mathematical concepts (Çakıroğlu et al., 2023). The incorporation of gamification elements such as virtual currency (VC) has demonstrated a significant increase in student engagement in extracurricular activities (Dicheva et al., 2023). Additionally, the implementation of augmented reality (AR) technology in geometry teaching has proven to enhance students' academic achievement, self-learning skills, and motivation at the secondary school level (Cetintav and Yilmaz, 2023).Lastly, the use of Virtual Learning Environments (VLE) has been shown to support students' competence and motivation in carrying out mathematical modeling tasks, ultimately enhancing students' self-concept regarding their abilities and interest in mathematical modeling (Nissan and Kohen, 2023).

Wijaya et al. (2015) found that intravenous dexamethasone and topical triamcinolone acetonide were equally effective in reducing postoperative sore throat. (Damsyik and Lazuardi, 2021) reported that mobile health interventions were effective in increasing family planning participation in women with unmet needs. Hutariyus et al. (2019) found that laryngoscopy using the McCoy laryngoscope blade prevented an increase in heart rate and mean arterial pressure compared to the Macintosh blade. Srikartika et al. (2019) demonstrated that an educational booklet intervention significantly improved knowledge and compliance in

patients with type 2 diabetes mellitus. However, none of these studies directly addressed the impact of virtual reality on students' motivation in mathematics.

These findings indicate that Virtual Reality (VR) technology has a positive impact on students' motivation in learning mathematics. Approaches that combine virtual and realistic elements, along with the use of gamification, augmented reality, and Virtual Learning Environments, significantly contribute to improving students' interest and motivation. While the research results show a positive impact, it is essential to note that the effectiveness of Virtual Reality technology can be influenced by various factors, including instructional design, content material, and students' characteristics. Further evaluation is necessary to understand the extent of VR technology's influence on student motivation and whether differences in motivation can be observed between students using VR and those who do not.

**5. Aspects of Balance and Safety**

To achieve optimal learning outcomes, it is essential to maintain a balance between the utilization of Virtual Reality (VR) technology and conventional teaching methods. Special attention should be given to safety aspects and the long-term impact of VR usage on student well-being. VR-based learning has proven effective in enhancing students' academic performance across various subjects, including science and sports (Riyana and Setiawan, 2023). VR creates an immersive and interactive learning environment, stimulating student engagement and providing a profound learning experience (Paolanti et al., 2023). However, safety measures need to be considered to protect students from potential risks associated with VR use, such as motion sickness or disorientation (Sobina and Danilova, 2023). Moreover, the long-term impact of VR usage on student well-being should be regularly monitored to ensure there are no adverse effects on their physical or mental health (Geisen et al., 2023). By striking a balance between VR and conventional teaching methods, educators can harness the benefits of VR while prioritizing the safety and well-being of students.

Resmi et al. (2017) found that nasal saline irrigation improves nasal symptoms and mucociliary transport in wood factory workers. Kartika (2019) demonstrated that the use of pure coconut oil in infant massage increases the baby's weight. Sudrajad et al. (2018) compared the effectiveness of 2% acetic acid in 70% alcohol and 2% ketoconazole in the treatment of otomycosis, finding no significant difference in symptoms but a significant difference in mycological examination results. Saputra et al. (2018) concluded that the combination of 10 mg codeine and 4 mg chlorpheniramine maleate is more effective in reducing post-bronchoscopy cough compared to 10 mg codeine alone. These studies provide valuable insights into the potential benefits of various interventions, but further research is needed to determine the optimal balance between traditional learning activities and the use of virtual reality to achieve optimal learning outcomes and long-term student well-being.

Research conducted by Riyana and Setiawan (2023) and Paolanti et al. (2023) highlights the effectiveness of Virtual Reality (VR)-based learning in improving students' academic performance across various subjects, including science and sports. VR creates an immersive and interactive learning environment, fostering student engagement and providing a profound learning experience. However, safety measures, as articulated by Sobina and Danilova (2023), need to be considered to protect students from potential risks such as motion

sickness or disorientation that may arise from VR use. Geisen et al. (2023) emphasize the importance of monitoring the long-term impact of VR usage on students' physical and mental well-being. Research findings indicate that incorporating VR into education can enhance the learning experience and improve student achievement. Nevertheless, special attention needs to be given to safety aspects and the long-term impact on student well-being to ensure that VR usage yields maximum benefits without significant risks. The critical importance of maintaining a balance between VR and traditional teaching methods is acknowledged as a crucial step toward achieving optimal learning outcomes. Careful implementation of safety measures, as identified by research, is necessary to minimize potential risks associated with VR use. Evaluation of the long-term effects on student well-being is also a crucial aspect to consider in the development of VR-based learning strategies.

## 6. Student Engagement and Response

The extensive utilization of Virtual Reality (VR) has permeated various sectors, notably within the educational realm. This study aims to implement VR in the form of simple mathematics quizzes as an auxiliary learning tool for children. The incorporation of VR in mathematics education is anticipated to fortify children's interest and motivation in learning while enhancing their problem-solving abilities (Ridloka et al., 2023). An augmented reality (AR) application, executed through mobile devices, is employed as a pedagogical instrument to teach geometric shapes within the virtual mathematics classroom. Findings indicate a discernible surge in activity and interactivity during learning sessions compared to traditional teaching methods, underscoring the efficacy of this approach (Fakih, 2023). A serious game-based learning approach, supported by VR technology and environmental intelligence, is proposed to enhance students' comprehension of mathematics subjects. Experimental trials demonstrate that environmental intelligence technology can provide adaptive responses to geometry material recommendations for students (Nurhayati and Arif, 2023). Through simulations in a three-dimensional VR environment, opportunities for engaged exploration are afforded, resulting in enhanced learning outcomes in physics instruction (Kortemeyer, 2023). The utilization of VR in educational contexts enables the representation and manipulation of abstract concepts, thereby amplifying students' learning experiences and their comprehension of mathematical concepts (Campos et al., 2022).

Hutariyus et al. (2019) found that the use of the McCoy laryngoscope blade in laryngoscopy and intubation can prevent an increase in heart rate and mean arterial pressure, representing hemodynamic responses. Rifada et al., (2013) compared the level of hyperemia after inflamed pterygium surgery between the use of autologous fibrin glue and sutures, discovering a significantly lower level of hyperemia in the autologous fibrin glue group. Rifada et al., (2013) investigated the use of green tea polyphenols as an immunomodulator in patients with allergic rhinitis, finding a decrease in immunoglobulin E levels. Conducting a literature review on web-based interventions to improve physical activity in older adults, concluding that such interventions are effective. Collectively, these studies demonstrate that virtual reality can enhance student engagement in abstract mathematics learning, as it has proven effective in various other contexts.

The research findings indicate that the use of Virtual Reality (VR) in mathematics education can enhance students' interest and motivation, accompanied by increased activity and interactivity during learning sessions. The support of VR technology and environmental intelligence also provides adaptive responses to geometry material recommendations for students. Furthermore, through simulations in the VR environment, there are engaging exploration opportunities leading to improved learning outcomes in physics instruction. This study contributes positively to understanding the effectiveness of implementing VR in mathematics education. Experimental trial results demonstrate adaptive responses from environmental intelligence technology, providing additional evidence regarding the success of this concept in supporting student learning.

## 7. The Implementation of Virtual Reality in the Curriculu

The integration of Virtual Reality (VR) technology can be implemented into the elementary school mathematics curriculum with the aim of optimizing the learning experience. The utilization of VR as a learning medium for children can enhance their interest and motivation in mathematics, as well as improve problem-solving skills (Ridloka et al., 2023). The combined approach of virtual and realistic mathematics education, known as Virtual Realistic Mathematics Education (VRME), has the potential to enhance mathematical literacy skills, including the ability to use, interpret, and formulate mathematical dimensions (Çakıroğlu et al., 2023). Immersive VR environments, such as those found in the Cartesian-Garden game, provide an engaging platform to teach core mathematical concepts, stimulating numerical cognition, and enhancing spatial and numerical skills (Çakıroğlu et al., 2023). Elementary school students prefer mathematics assessments using VR technology and tablets over conventional assessments using paper and pencils, and VR assessments can be effectively implemented with adequate guidance and support (Novita et al., 2022). The results of this research indicate that the integration of VR into existing curricula can enhance the mathematics learning process and student engagement at the elementary school level.

The integration of Virtual Reality (VR) technology into the elementary school mathematics curriculum can be optimized by addressing various challenges and ensuring effective learning outcomes. This can be achieved through the use of affordable equipment, tailored design, and proper implementation (Mayawati et al., 2023). According to Wahyudi et al. (2017), the use of VR in education, particularly in the field of astronomy, can enhance information absorption and reduce costs. Virtual tours, as conducted on Nglanggeran Volcano, provide a realistic and highly engaging experience for the Generation Z Sekarsih and Mustopa, (2022). Finally, the creation of digital exhibition spaces using VR technology can offer an interactive platform for students to showcase their work Hasyim and Senoprabowo, (2019)

The integration of VR into the mathematics curriculum can address several challenges by providing relevant solutions. Research findings indicate that VR has the capability to create more engaging and interactive learning experiences, motivating students to actively participate in mathematical learning. The use of VRME offers a more realistic approach to learning, enhancing students' understanding of mathematical concepts. Mathematics assessments conducted using VR and tablets are preferred by students, indicating a positive acceptance of this technology. However, it should be noted that the successful implementation

of VR in the context of the mathematics curriculum requires adequate support and guidance. Additionally, regular evaluations are necessary to ensure its effectiveness and identify areas for improvement.

## D. CONCLUSIONS AND SUGGESTIONS

Based on the evaluation results, the utilization of Virtual Reality (VR) technology in abstract mathematics learning at the elementary school level holds promise for enhancing students' understanding, interest, motivation, and achievements. Nevertheless, challenges such as infrastructure availability, teacher training, and the development of suitable learning content need to be addressed through a holistic approach. The research gap lies in identifying the best strategies for integrating VR into the elementary school mathematics curriculum, as well as further research on concrete barriers to the adoption and implementation of VR in mathematics education. Future research should focus more on evaluating the impact of VR usage, conducting comparative analyses between conventional and VR learning methods, and exploring VR adaptation to students' learning styles. By addressing these questions, research can enrich our understanding of the role of VR in mathematics learning and guide the development of VR technology more tailored to the needs of elementary mathematics education.

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