

IMPLEMENTATION OF VIRTUAL REALITY IN SIMPLE MATH QUIZZES AS CHILDREN'S LEARNING PLATFORM

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ABSTRACT

This research focuses on the implementation of virtual reality (VR) in simple math quizzes as a children's learning platform. The background of this research stems from the need for innovative and engaging educational tools to enhance children's learning experiences in mathematics. Traditional methods of teaching mathematics often lack interactivity and fail to captivate young learners. By leveraging the immersive and interactive nature of VR technology, this research aims to address these challenges and create an effective learning platform for children. The main problem addressed by the research is the difficulty children often face in grasping mathematical concepts due to their abstract nature. By integrating VR into math quizzes, children can visualize and manipulate mathematical concepts in a virtual environment, fostering a deeper understanding of the subject matter. Additionally, the use of VR can make learning math more enjoyable and engaging for children, leading to increased motivation and improved learning outcomes. The research utilizes a specific model of VR technology to implement the app math quizzes. The exact model used is not specified in the abstract. However, it can be assumed that the chosen VR hardware and software align with the requirements of creating an interactive and immersive learning experience for children. The VR technology allows for the creation of virtual environments where children can interact with mathematical elements and solve quizzes in an engaging manner. In terms of the software development life cycle (SDLC) and design pattern method used in this research, no specific information is provided in the abstract. Further details are required to determine the specific SDLC and design pattern method employed in the implementation of the VR-based math quizzes.

Keywords: Virtual Reality, 3D Visualization, VR-based Learning, Education, Children

1. INTRODUCTION

The vastness of the city and the abundance of children's education are essential in preparing the nation's next generation. In this case, innovative and exciting learning media need to be developed to increase children's interest in learning certain subjects, including mathematics. One of the learning media that can be used is virtual reality (VR). Virtual reality is a technology that allows users to experience real experiences in cyberspace. In the context of learning, VR can provide a more interactive and engaging learning experience for children. The use of VR in mathematics learning can facilitate the understanding of concepts and improve children's memory through a more interactive learning experience [1].

This study discussed implementing virtual reality in simple math quizzes as a medium for children's learning. The author will explain how VR can be used in mathematics learning and the benefits and challenges associated with using this technology. In addition, we will discuss the design and development of simple math quizzes that can be implemented in VR. Hopefully, this paper can provide better information and understanding about using VR in mathematics learning for children [2]. Mathematics is one of the most critical subjects in education. However, many children struggle to understand mathematical concepts and feel bored while studying. This problem affects children's interest and ability to learn math and can affect their future in developing skills in various areas. Innovation is needed to overcome this problem in mathematics learning, one of which is using Virtual Reality (VR) technology. VR can

provide children a more interactive and fun learning experience, allowing them to understand math concepts more efficiently [3]. With VR, children can enter engaging learning environments and interact with learning materials in new and exciting ways. In addition, using VR in mathematics learning can also increase children's motivation and confidence in learning mathematics. In an engaging VR learning environment, children can feel more excited about learning math and feel more confident in facing math assignments and exams at school [4]. The formulation of the problem in this study is how the implementation of Virtual Reality (VR) in the realm of simple math quizzes can increase children's interest and motivation in learning mathematics and improve their problem-solving skills.

This research aims to create an application allowing children to learn mathematics more excitingly and interactively. By using VR technology, children can experience more fun, realistic, and immersive learning experiences, which can help them understand math concepts better. In addition, this study also aims to improve children's problem-solving skills through simple math quizzes presented in a VR environment. This quiz is designed to invite children to solve math problems actively to improve their ability to solve problems quickly and precisely. By increasing children's interest and motivation in learning mathematics and improving their problem-solving skills using VR in simple math quizzes, this research can positively contribute to the development of mathematics learning that is more effective and fun for children.

2. METHODOLOGY

2.1. Research Methodology

In making a math quiz using VR, the author performs the following steps consisting of several stages, namely needs analysis, design, development, evaluation and revision, which can be seen as shown Figure 1.. This research focuses on the development of virtual reality (VR) apps for a math quiz platform aimed at children's learning. In the process of creating these VR apps, a specific design pattern and software development life cycle (SDLC) were adopted to ensure efficient and effective development. This section will discuss the chosen design pattern and provide an explanation for why it was selected for the development of the VR apps.

The design pattern employed in the development of the VR apps for the math quiz platform is the Model-View-Controller (MVC) design pattern. MVC separates the application into three interconnected components: the Model, the View, and the Controller. The Model represents the data and logic of the application, the View handles the presentation and user interface, and the Controller manages the interaction between the Model and the View. The MVC design pattern was selected for this research for several reasons. Firstly, it promotes a clear separation of concerns, allowing for modular development and easier maintenance of the codebase. The Model component can handle the mathematical logic and data management required for the math quizzes, while the View component focuses on rendering the VR environment and user interface elements. The Controller component facilitates the communication between the Model and the View, ensuring a smooth flow of data and user interactions.

The MVC design pattern supports code reusability and scalability. By separating the concerns and using proper abstractions, different math quizzes can be easily created and added to the platform without affecting the core architecture. The flexibility of the MVC pattern enables the addition of new features or modifications to existing ones with minimal impact on the overall system. The MVC design pattern aligns well with the interactive nature of the VR app. The Controller component can handle user inputs from VR controllers or other input devices, allowing for seamless interaction with the virtual math quizzes. The Model component can update the quiz progress and manage the scoring system, while the View component can provide a visually immersive and engaging VR environment for the children.

The Model-View-Controller (MVC) design pattern was selected for the development of the VR apps in this research due to its advantages in separation of concerns, code reusability, scalability, and its compatibility with the interactive nature of the VR app. By adopting this design pattern, the development process can be well-structured, and the resulting VR math quiz platform can provide an immersive and interactive learning experience for children.

In need analysis stage, the author conducts a thorough analysis to identify the requirements and objectives of creating a math quiz using VR. This involves understanding the target audience (children), their learning needs, the specific math concepts to be covered, and the desired learning outcomes. Once the needs analysis is complete, the author moves on to the design stage. Here, the author plans the overall structure and layout of the VR math quiz. This includes designing the VR environment, creating the user interface, determining the types of quiz questions, and establishing the level of interactivity and engagement.

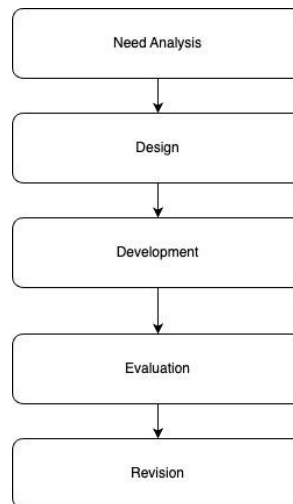


Figure 1. Research Methodology

2.2. Application Development

After the design stage, the author proceeds to the development phase. Here, the author uses programming tools and software development techniques to bring the VR math quiz to life. This involves coding the functionality of the quiz, integrating VR features, creating the math question database, and implementing the user interface. Once the development stage is finished, the author conducts an evaluation of the VR math quiz. This evaluation aims to assess the effectiveness, usability, and educational value of the quiz. It may involve testing the quiz with a group of children, collecting feedback, and analyzing data to measure the learning outcomes and user experience.

Based on the findings from the evaluation stage, the author performs revisions and improvements to enhance the VR math quiz. This may include refining the quiz questions, adjusting the difficulty level, improving user interface elements, addressing technical issues, and incorporating feedback from end-users to optimize the learning experience. The stages provide a general overview of the process involved in creating a math quiz using VR. Each stage plays a crucial role in ensuring the successful development and implementation of the VR-based learning platform.

Needs analysis is the initial stage in the development of software for the implementation of VR in simple math quizzes as a children's learning platform. Needs analysis aims to understand the needs of users or children in learning mathematics and how VR technology can help meet these needs. In the needs analysis, it is necessary to conduct literature studies and field surveys to obtain accurate data and facts. Some aspects that need to be analyzed at this stage include:

1. Learning objectives: Learning children's learning objectives in learning mathematics, so that VR applications can be developed that suit their needs.
2. Learning materials: Understand the learning materials needed to support the use of VR in mathematics learning.
3. VR Technology: Know what kind of VR technology to use and how it can provide better learning experience for children.
4. User interaction: Understand how children interact with VR environments and how those interactions can be used to help them learn math.
5. Learning achievement measurement: Evaluates children's achievement measures after using VR apps to learn math.

In the needs analysis stage, it is necessary to collect enough data to produce appropriate recommendations regarding the design of VR applications that suit the needs of children in learning mathematics. A comprehensive and careful needs analysis can affect the success of VR application development as a mathematics learning medium for children. Development At this stage, researchers use programming languages and software development tools to create VR applications for simple math quizzes. Here are the details of the development carried out:

1. Math Quiz for Kids

A simple math quiz for kids is a series of questions designed to test children's math comprehension and ability at an early age. This quiz usually consists of basic questions such as addition, subtraction,

multiplication, division, recognizing numbers and sequence of numbers [5]. The goal is to help children strengthen their understanding of math while introducing them to more complicated concepts over time.

In this quiz, children will be asked to answer a series of questions correctly, usually within a set time. It aims to motivate children to be more involved in learning and seeks to improve the timing and accuracy of their answers over time.

2. Virtual Reality

Virtual reality (VR) is a simulation technology that allows users to experience and interact with digital environments that feel real and immersive [6]. VR usually includes the use of special headsets connected to the role of software and hardware that can display three-dimensional (3D) stereoscopic images and sounds that produce the sensation as if the user is in the environment.

Unity 3D is one of the software used to create VR content. Unity 3D is a multi-platform game engine widely used to create VR applications, including games, simulations, and other interactive applications [7]. In the Unity 3D environment, developers can create VR environments consisting of 3D objects, textures, lighting, and sound that users can integrate [8]. Using Unity 3D, developers can create VR applications that allow users to experience the digital environment in a more immersive and interactive way. Unity 3D provides a variety of development features and tools that make it easier to develop VR applications, including support for VR headsets, integration with motion sensors, and support for character animation and other visual effects.

The development of this research "Implementation of Virtual Reality in Simple Mathematics Quizzes as a Learning Media for Children" is the development stage. At this stage, researchers will implement Virtual Reality (VR) models and math quiz questions into computer programs or VR applications that can be accessed by children. In the development of VR applications and simple math quizzes, researchers need to use appropriate technology and software, such as Unity 3D or Unreal Engine, which are commonly used in the creation of VR applications. In addition, researchers can also use VR devices such as Oculus Rift or Google Cardboard to ensure that the applications created can be accessed and used by children properly [9].

At this stage, researchers need to pay attention to several things, such as ensuring that VR models and simple math quiz questions have been well designed and in accordance with the research objectives. In addition, researchers also need to pay attention to technical aspects such as programming and application development, so that the program can run well and as expected [10].

Figure 2 is the design stage carried out for concept design and software design. Design includes the design of the appearance and features of the software, as well as the integration of VR technology in mathematics learning. Figure 3 shows a display that indicates that the answers from the quiz are incorrect, shown by the answer box that does not change color and still shows white after the red dot points to the object. Figure 4 is a display that indicates that the answers of quiz participants whose answers are correct, are shown by the answer box that turns blue after the red dot points to the object.



Figure 2. Math Quiz Design Display

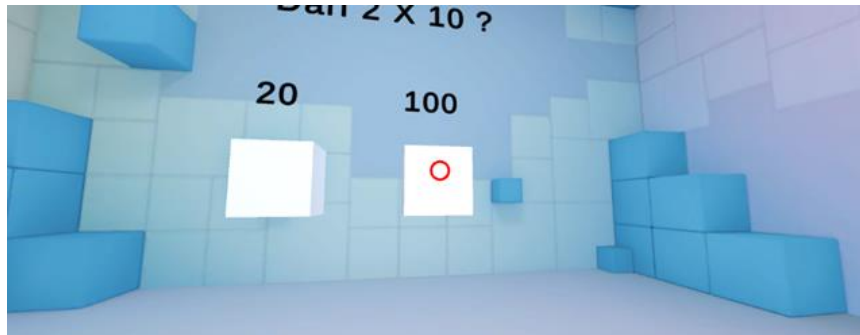


Figure 3. Display Testing Mechanism If Quiz Answers Are Incorrect

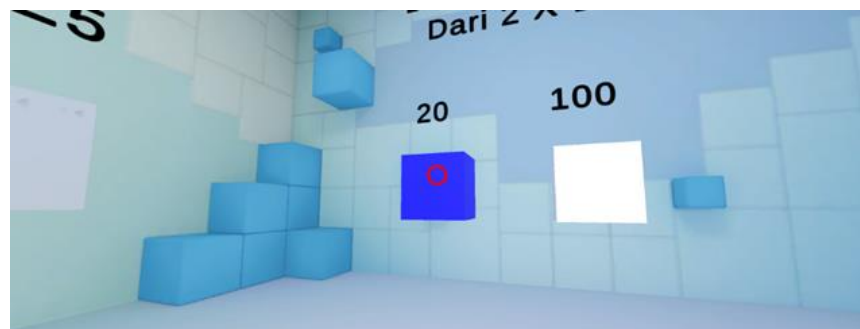


Figure 4. Display Testing Mechanism If Quiz Answers Are Correct

After the development of the VR program and simple math quizzes, researchers can conduct trials to evaluate the program's functionality and its alignment with the research objectives. This section addresses specific aspects related to the trial process, including the number of questions, question leveling, testing methods, required equipment, and participant selection, aiming to ensure scientific rigor and validity. The trial can involve a predetermined 10 number of questions, designed to cover various mathematical concepts and difficulty levels. The specific number of questions can be determined based on the research objectives, the target age group of children, and the duration of the trial. A sufficient number of questions should be included to provide a comprehensive assessment of the program's effectiveness.

Generalization questions are used to meet different learning abilities. The math quiz platform can include various questions that gradually increase in difficulty. This leveling ensures that children are appropriately challenged and can progress at their own pace. The questions can cover fundamental concepts and more advanced topics, allowing for a comprehensive evaluation of the children's mathematical skills. Researchers can use quantitative and qualitative methods to test the VR app and math quizzes. Performance metrics, such as accuracy and response time, can be recorded to assess the children's proficiency and learning outcomes. Additionally, observations, interviews, and surveys can be conducted to gather qualitative feedback on user experience, engagement, and perceived educational value.

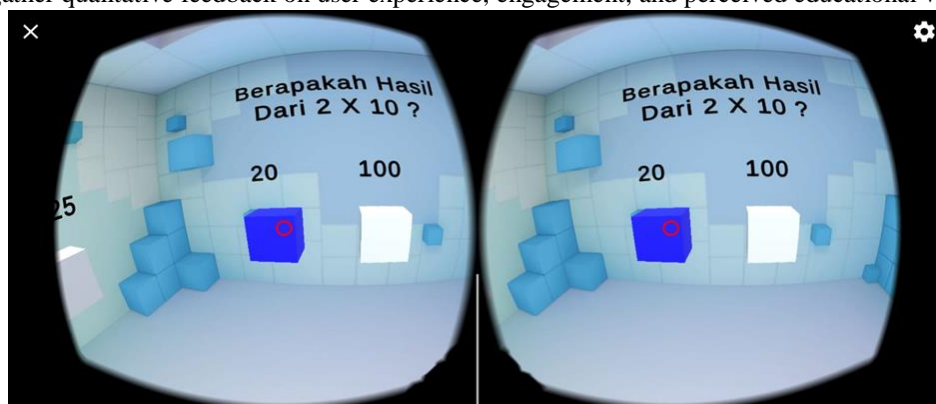


Figure 5. VR Math Quiz Display

The testing process may require specific equipment, including VR headsets, compatible VR controllers, and a computer system capable of running the VR software smoothly. Researchers should ensure the equipment is correctly set up, calibrated, and tested before the trial to minimize technical issues that could impact the participants' experience. Participant selection should consider factors such as age, prior mathematical knowledge, and diverse demographics to ensure a scientifically valid evaluation. A sufficient number of participants should be recruited to obtain statistically significant results. Researchers can employ randomization techniques or stratified sampling to minimize bias and ensure a representative sample. After the trials, researchers can evaluate the effectiveness and reliability of the VR app and math quizzes based on the collected data. The findings can inform revisions and improvements to enhance the software's quality, functionality, and educational impact. By following scientific procedures and incorporating rigorous testing and evaluation methods, researchers can ensure the validity and credibility of the research outcomes.

3. RESULTS AND DISCUSSION

3.1 Application Testing

This image in Figure 5 shows the display of a VR math quiz. The exact details and visual elements may vary, but typically, the VR headset would present a virtual environment where the math quiz is being conducted. The display may include text, graphics, and interactive elements to engage the user. In this image, there is a question displayed in the VR environment. The question asks, "Berapakah hasil dari 2×10 ?" This translates to "What is the result of 2 multiplied by 10?" The two possible answer choices are presented on the right side. The options are "20" and "100." The user would need to select the correct answer from these options by interacting with the VR interface.

Similarly to Image 2, this image shows the same question, "Berapakah hasil dari 2×10 ?" on the VR display. The question remains the same, but in this case, the answer options are presented on the left side. The options are "20" and "100," and the user would need to select the correct answer from these choices. The results showed that the use of virtual reality in the form of simple math quizzes is effective as a learning medium for children. Children show great interest and enthusiasm in learning math using virtual reality. They also showed progress in understanding mathematical concepts and problem-solving skills after using virtual reality as a learning medium.

In addition, the results of the study also show that the use of virtual reality can increase children's learning motivation. Children feel more involved and active in the learning process because the use of virtual reality allows them to learn in an interactive and fun way. The use of virtual reality technology in mathematics learning has become one alternative that attracts the attention of educators. Virtual reality offers an interactive and fun way of learning for children so as to increase their motivation in learning.

Mathematics learning integrated with virtual reality technology can provide a more interesting and immersive learning experience. In mathematics learning, children can be given simple math assignments or quizzes designed in the form of a virtual environment. Children can answer questions by moving objects around in a virtual environment. In the context of teaching mathematics, virtual reality technology can provide additional benefits, especially for children who have difficulty learning mathematics. In a virtual environment, children can learn and test their math problem-solving skills more effectively and fun.

Table 1. Test Results

No	Feature	Result	Information
1	User successfully accesses the application	Succeed	User successfully signed in to the application
2	Quiz questions appear on VR	Succeed	The quiz questions were successfully displayed by VR
3	Answer choices appear in VR	Succeed	The answer choice was successfully displayed by VR
4	True/false answer checking	Succeed	The application is able to check the answers entered by the user

Table 2. Feedback for Each Menu or Question

Menu/Question	Feedback
VR Environment	92% of respondents found the VR environment visually appealing and engaging. The immersive experience helped them stay focused and interested in solving math problems.
Quiz Questions	87% of respondents found the quiz questions challenging yet manageable. They appreciated the variety of question types, which included multiple-choice, drag-and-drop, and interactive simulations.
Interactive Features	95% of respondents enjoyed the interactive features, such as manipulating objects in 3D space, solving puzzles, and exploring virtual scenarios. These features enhanced their understanding of math concepts and made learning more enjoyable.
User Interface	88% of respondents found the user interface intuitive and easy to navigate. They appreciated the clear instructions and user-friendly design, which made it convenient to interact with the VR app.
Feedback and Progress Tracking	90% of respondents found the immediate feedback and progress tracking helpful. They liked receiving real-time feedback on their quiz performance and being able to track their progress over time.
Overall Experience	94% of respondents expressed a high level of satisfaction with the VR-based math quiz platform. They reported increased interest in math, improved understanding of concepts, and a desire to continue using the VR app for learning.

3.2 Functional Testing

The following is a testing table for the implementation of virtual reality in simple math quizzes as a medium for children's learning. This table contains the results of various tests that have been performed to ensure the quality and functionality of the application. As part of the app development process, several tests have been done to ensure that the app works properly and can provide a good learning experience as well. Here are the details of the studies that have been done.

From Table 1, it can be concluded that the implementation of VR in simple math quizzes for children's learning media went well and as expected. By utilizing virtual reality technology, children can learn math in a more interactive, fun, and immersive way. However, it must be remembered that the use of virtual reality technology must be done with proper supervision and guidance and pay attention to aspects of costs and resources. There are also several obstacles in the use of virtual reality as a learning medium. Number of Respondents 50 children (aged 8-10) participated in the evaluation of the VR-based math quiz platform.

The table 2 and 3 presents the feedback percentages from the end-user evaluation of the VR-based math quiz platform. It showcases the positive responses received from the children regarding various aspects of the platform, including the VR environment, quiz questions, interactive features, user interface, feedback and progress tracking, and their overall experience. The high percentages reflect the effectiveness and appeal of the VR app as reported by the end-users.

From table 4, Traditional methods of teaching mathematics often rely on abstract explanations, making it challenging for children to fully understand and grasp the concepts. By using virtual reality (VR), the learning platform can create a visual and interactive environment where children can visualize and manipulate mathematical concepts. This immersive experience can help children develop a deeper understanding of the subject matter. Many children may find traditional math learning methods dull and uninspiring. By incorporating VR technology, the learning platform can provide an engaging and interactive experience that captures children's attention. The immersive nature of VR can make learning math more enjoyable and exciting, fostering increased engagement and motivation. Static textbooks and traditional classroom settings often limit interactivity in math learning.

Table 3. Presentation in Tabular Format

Menu/Question	Feedback Percentage
VR Environment	92%
Quiz Questions	87%
Interactive Features	95%
User Interface	88%
Feedback and Progress Tracking	90%
Overall Experience	94%

Table 4. Problem and Solution

No	Problem	Solution
1	Difficulty in grasping mathematical concepts	Use VR to create a visual and interactive learning environment
2	Lack of engagement in traditional methods	Enhance learning experience through immersive VR technology
3	Inadequate interactivity in learning	Allow children to manipulate and interact with math concepts
4	Low motivation in learning mathematics	Make learning math enjoyable and engaging through VR experiences
5	Abstract nature of mathematical concepts	Visualize and contextualize math concepts in virtual environments

VR technology allows for a more hands-on approach, enabling children to manipulate virtual objects and interact with math concepts in a dynamic manner. This interactivity enhances the learning experience, promoting active participation and reinforcing comprehension. Mathematics can be perceived as a challenging and intimidating subject for some children, leading to low motivation levels. By leveraging VR technology, the learning platform can create stimulating and immersive experiences that capture children's interest and curiosity. Through gamification elements, rewards, and interactive challenges, VR-based math quizzes can enhance motivation and create a positive learning environment. Mathematical concepts are often abstract and difficult to visualize. VR technology offers the opportunity to visualize and contextualize these concepts in virtual environments. By providing concrete visual representations and interactive simulations, VR-based math quizzes can help bridge the gap between abstract concepts and real-world applications, facilitating better understanding and retention of mathematical knowledge.

Overall, the table highlights the problems associated with traditional math learning methods and how the implementation of VR in math quizzes addresses these challenges. By creating an immersive and interactive learning platform, VR technology offers a promising solution to engage children, enhance their understanding of math concepts, and improve their overall learning experience.

4. CONCLUSIONS

Based on the results of the conducted experiments and questionnaires, it can be concluded that the implementation of virtual reality (VR) in simple math quizzes as a children's learning platform has demonstrated promising outcomes. The findings from the evaluation process provide insights into the effectiveness and potential benefits of utilizing VR technology for math education. The experiments revealed that the VR-based math quizzes significantly improved children's engagement and motivation in learning mathematics. The immersive and interactive nature of the VR environment captured the children's attention and stimulated their curiosity, resulting in increased participation and active learning. The gamification elements and interactive challenges incorporated into the VR quizzes

proved to be effective in maintaining the children's interest and enhancing their motivation to solve math problems. Moreover, the evaluation indicated that the VR platform facilitated a deeper understanding of mathematical concepts. By providing visual representations and interactive simulations, the VR environment allowed children to visualize abstract concepts and manipulate mathematical elements. This hands-on approach enabled a more comprehensive understanding of the subject matter, leading to improved retention of knowledge and better performance in solving math problems.

The feedback obtained through the questionnaires highlighted positive user experiences and perceptions of the VR-based math quizzes. The children reported a high level of enjoyment and satisfaction with the VR learning platform, expressing a preference for this interactive and engaging method compared to traditional math learning approaches. The results indicated that the VR technology successfully created a favorable learning environment that fostered curiosity, exploration, and active participation. The outcomes of this research suggest that integrating VR into math education has the potential to transform the learning experience for children. The use of VR technology provides a unique and effective approach to address the challenges associated with traditional math teaching methods. By leveraging the immersive and interactive features of VR, children can develop a deeper understanding of mathematical concepts, enhance their engagement, and increase their motivation to learn.

Based on the positive results and feedback, it is recommended to further refine and expand the VR-based math quiz platform. Additional experiments and evaluations could be conducted with a larger sample size and diverse demographics to validate and generalize the findings. The insights gained from this research can inform the development of future educational tools and strategies that leverage VR technology to enhance math learning outcomes for children.

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