The Effect of using Virtual Reality Media on the Geometric Skills of Elementary School Students

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ABSTRAK

Penelitian ini dilatarbelakangi oleh rendahnya kemampuan geometris siswa sekolah dasar. Rendahnya kemampuan geometris ini disebabkan oleh guru tidak menggunakan media pembelajaran yang dapat mengembangkan kemampuan geometri siswa sekolah dasar maka pada penelitian sebelumnya dikembangkanlah media pembelajaran virtual reality yang telah dinyatakan layak untuk diterapkan disekolah dasar. Media virtual reality ini perlu kajian lanjutan untuk mengkaji pengaruhnya terhadap kemampuan geometris siswa sekolah dasar. Tujuan penelitian ini adalah untuk mengkaji pengaruh penggunaan media virtual reality terhadap kemampuan geometris siswa sekolah dasar. Penelitian ini menggunakan pendekatan kuantitatif dengan jenis penelitian quasi eksperimen yang melibatkan 200 siswa kelas V. Instrumen pengumpulan data menggunakan soal test kemampuan geometris. Teknik analisis data menggunakan Teknik analisis statistic berbantuan SPSS 26 dengan uji yang dilakukan yaitu uji prasyarat, uji hipotesis dan uji lanjut. Hasil penelitian secara umum menyatakan bahwa terdapat pengaruh penggunaan media virtual reality terhadap kemampuan geometris siswa sekolah dasar. Implikasi penelitian ini dapat dijadikan sebagai referensi guru untuk dapat meningkatkan kemampuan geometris siswa sekolah dasar.

ABSTRACT

This research is motivated by the low geometric abilities of elementary school students. This low geometric ability is caused by teachers needing to use instructional media that can develop elementary school students' geometric abilities. In previous research virtual reality learning media was developed which has been declared feasible to be applied in elementary schools. This virtual reality media needs further study to examine its effect on the geometric abilities of elementary school students. This study sought to analyze how primary school pupils' geometric skills were affected by their use of virtual reality media. In this study, 200 fifth-grade students participated in quasi-experimental research with the quantitative approach. Geometric aptitude questions were utilized as data collection instruments. Prerequisite tests, hypothesis tests, and further tests were performed with data analysis techniques using SPSS 26. According to the study, elementary school children's geometric abilities are impacted by their use of virtual reality media. Teachers might use the implications of this research as a guide to help their kids' geometric skills in elementary school.

1. INTRODUCTION

Every student at every educational level, especially in primary school, must be able to master the subject of mathematics. Children must learn math in elementary school because it is one of the fundamental subjects that helps pupils develop their comprehension and problem-solving skills (Blumberg & Fisch, 2013; Brooke, 2013). By becoming math experts, students can improve their logical, analytical, and critical thinking abilities. Additionally, students can comprehend many basic mathematical concepts and principles related to numbers, geometry, algebra, statistics, and probability. Students who were proficient in arithmetic might also benefit from more informed and logical decision-making in their daily lives. To continue learning at a higher level, whether in high school or college, knowledge of mathematics is equally crucial (Aunio & Räsänen, 2016; Staddon, 2022). Therefore, pupils must learn mathematics in elementary

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school to develop their understanding, abilities, and confidence to deal with future math lessons and solve difficulties in daily life.

Geometric ability is one of the talents that primary school pupils should possess. According to previous study geometric aptitude refers to pupils' understanding, analysis, and manipulation of geometric objects such as points, lines, planes, and three-dimensional objects (Schoevers et al., 2020). Geometric ability encompasses the capacity to comprehend and represent geometric objects both visually and mathematically, as well as the comprehension of the relationships between these items (Hwang & Ham, 2021; Smieskova, 2017). This ability encompasses the capacity to create, comprehend, and work with geometric models, diagrams, and graphs. Elementary school kids need to be proficient in geometry since it will help them learn other abilities necessary for the demands of the 4.0 era.

However, the researchers discovered that, according to their examination of the literature, elementary school kids still have poor geometrical skills (Abdullah & Zakaria, 2013; Hawes et al., 2017). This fact is supported by the findings of the initial assessment of the geometric aptitude of 60 primary school pupils, who had an average score of 56.87 with the category less. This indicates that primary school kids' geometrical skills are still considered to be poor. Consequently, there is a need for measures to be taken to solve these issues. Additionally, learning media must be modified to reflect the advancements of period 4.0, where kids are interested in technological matters. As a result, in earlier experiments, researchers created a technology-based learning tool to enhance primary school pupils' geometrical skills (Hsiao et al., 2022; Musa & Ziatdinov, 2015). The educational tool is a virtual reality learning tool that has been approved as legitimate and practicable for usage by professional experts.

According to previous study virtual reality media is a learning tool that uses computer simulation technology to let users engage and experience artificial worlds that resemble the real world (Alalwan et al., 2020). Virtual reality learning media is used to make abstract concepts, ideas, or theories more tangible and understandable for students. Students are required to take an active position in the virtual reality learning media, seeing, hearing, and feeling the world that has been built for them (Rong et al., 2022; Zulherman et al., 2021). Because it can portray geometrical concepts in concrete words so that kids can comprehend each one, this media is anticipated to be able to help elementary school pupils enhance their geometrical skills (Hidayat et al., 2020; Marchis, 2009). Further study is therefore required to ascertain the impact of virtual reality media consumption on primary school kids' geometric skills. This serves as the context for the current investigation into whether recently produced virtual reality media can influence primary school children's geometric skills.

This research is important to do because geometry ability is one of the skills that is very necessary for elementary school students. Various previous studies have stated that geometric abilities must be mastered from an early age. Previous study stated that geometric aptitude can improve innovation and creativity while helping to solve problems (Barana, 2021). Geometric skills can help primary school kids develop logical and critical thinking abilities. Elementary school kids' creativity and imagery skills can also be developed through geometric abilities (İbili et al., 2020; Setiana & Purwoko, 2021). Observing, analyzing, and visualizing an object or shape in three dimensions are all aspects of geometric ability. This visualization skill makes understanding product design, computer graphics, and architecture much more effortless. Students in elementary school can collaborate and communicate more effectively using their geometric skills. Students were proficient in geometry can better express their thoughts precisely and effectively when designing or modeling an object (Ferdiani et al., n.d.; Rellensmann et al., 2021). Additionally, students learn how to work in groups to solve issues or complete challenging assignments. Students who are good at geometry are more equipped for the digital age. The geometric ability is crucial to prepare elementary school kids for the increasingly sophisticated digital era. Students proficient in geometry in elementary school will be more capable of adapting to technological advancements and getting ready for the increasingly complex and interconnected world of work (Buckley et al., 2019; Fitriani, 2014). As a result, elementary school pupils must learn geometric concepts to be well-prepared for life in the increasingly complex 4.0 era.

This is an important reason for conducting this research. The purpose of this study was to examine the effect of using virtual reality media on elementary students' geometric abilities. Although research on the use of virtual reality media with primary school kids has started, it is still in its early stages. The study by previous study examines how virtual reality games affect primary school pupils' learning outcomes in mathematics (Rohmah & Bukhori, 2020). According to the study, virtual reality-assisted games can help elementary school kids learn mathematics more effectively. Then comes a study that examining how employing virtual reality affects elementary school kids' learning of music (Degli Innocenti et al., 2019). According to the study, elementary school pupils can learn music more effectively using virtual reality. Research conducted previous study looks at how employing virtual reality affects students' understanding of science in primary school (Ibáñez & Delgado-Kloos, 2018). According to the study, virtual reality can help

elementary school pupils learn more about science. Previous study look at the effectiveness of augmented and virtual reality in teaching math to elementary school students (Demitriadou et al., 2020). According to the study, using virtual and augmented reality technologies in elementary schools can boost students' enthusiasm and interest in arithmetic lessons. Other study examines the development of a virtual reality model on solar system material (Durukan et al., 2022). According to the study's findings, virtual reality media has been created that can help pupils learn more about the solar system. These papers show that more research on virtual reality in elementary classrooms still needs to be done. Virtual reality's use to enhance student learning results is still the subject of ongoing study. This is a differentiator and novelty in this research. This study analyze how virtual reality learning materials created for elementary school children learning the fundamentals of building spaces affect students' geometric skills.

2. METHOD

This study uses a quantitative approach. This type of research is experimental research. Quasi-experimental research was used in this study (Santoso & Madiistriyatno, 2021). Non-equivalent control group design was the method employed. The study's methodology is show in Table 1.

Table 1. Research Design

Group	Pre-Test	Treatment	Post-Test
Experimental	O1	X	O2
Control	O3		O4

Annotation:
X   :   Use of virtual reality learning media
O1 :   Pre-test (Geometric ability before using virtual reality learning media)
O2 :   Post-test (Geometric ability after using virtual reality learning media)
O3 :   Pre-test (Geometric ability before using the conventional model)
O4 :   Post-test (Geometric ability after using the conventional model)

This study using purposive sampling, 200 fifth graders made up the study's sample. Students were divided into two groups, namely the experimental group and the control group. The experimental group consisted of 100 students who learned using virtual reality, whereas the control group consisted of 100 students who learned using conventional methods. The research procedure begins with the researcher planning for each experimental and control class. Learning in the experimental class was structured using scientific learning using virtual reality learning media, while learning in the control class was structured based on scientific learning without using learning media. Each class is given the same material, namely spatial nets. In the control class learning process, students are asked to observe the geometric shapes presented by the teacher. Students and teachers ask about the shape of the space presented. Then students are asked to sit in groups, and students are given worksheets that contain the process of finding geometric nets. Students are asked to work on the worksheet. After students work together on worksheets, students are asked to present their findings.

Students' geometrical aptitude was assessed using 10 test essay questions with geometrical aptitude indicators. There were four types of geometric ability indicators: applied, verbal, visual, and logical abilities. Experts created, validated the test questions, and approved them as feasible. The question also completed a contract validation test to strengthen its legitimacy. The ten questions received a value of r-count larger than the r-table, according to the findings of the contract validation test, and were therefore deemed valid. The reliability of the question was also assessed, and it received a very high category score of 0.931.

The SPSS 26 application was utilized for data analysis in this study, which included preliminary tests, hypotheses tests, and further tests. The preliminary test included homogeneity and normality tests. The Kolmogorov-Smirnov test and the Shapiro-Wilk test results showed that all four data groups had sig values greater than 0.05, indicating that the class was regular. The homogeneity test indicated that the two groups were homogeneous because the sig value based on the mean is 0.352 higher than 0.05. Pair-sample t-tests were employed for hypothesis tests, and independent t-tests were utilized for further tests.

3. RESULT AND DISCUSSION

Result

Treatment was given to both groups following each class type. The first measurement (pre-test) and the measurement after receiving treatment (post-test) were both done twice. Later then, tabulations were made to analyze the measurement results. Table 2 presents the tabulation results.

Table 2. Tabulation of Research Data

	N	Minimum	Maximum	Mean	Std. Deviation
Experimental class pre-test	100	44	59	47.04	2.625
Experimental class post-test	100	75	100	86.05	5.299
Control class pre-test	100	43	59	46.71	2.176
Control class post-test	100	47	57	52.59	1.256
Valid N (listwise)	100				

The data collected after testing elementary school kids' geometric skills were displayed in Table 2. Performing the paired sample t-test was the next step. The four data were deemed customarily distributed, allowing for the paired sample t-test to be performed. This test aimed to calculate the average difference between the two samples. This experiment aimed to determine whether using virtual reality impacted primary school students' geometric skills. The outcomes of the paired samples t-test were show in Table 3.

Table 3. Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean Difference	Std. Dev	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Experimental Pre-Test - Experimental Post-Test	-41.677	6.029	0.765	-43.887	-36.865	-65.835	99	0.000
Pair 2	Pre-Test Control - Post-Test Control	-1.560	1.826	0.154	-1.745	-1.087	-6.974	99	0.100

Table 3 shows that the obtained sig value is 0.000, less than 0.05. This result indicated that the experimental class's average pre-test and post-test results differed. Thus, there are disparities in students' geometric skills before and after using virtual reality. Then, for additional testing, a homogeneity test was performed. The homogeneity test results showed that the two classes were homogeneous when the mean of the two variations was equal to 0.352. Following the declaration of homogeneity, additional tests could be run using the independent sample t-test. This study aimed to see whether there were any differences between elementary school children who learned geometry using virtual reality media and those who learned it using conventional models. These were the test findings. The result of T-test is show in Table 4.

Table 4. Independent Sample T-Test

		Levene's Test for Equality of Variances		t-test for Equality of Means		
		F	Sig.	t	df	Sig. (2-tailed))
The Geometric Skill	Equal variances assumed	112.282	0.000	68.523	198	0.000
	Equal variances not assumed			68.523	114.177	0.000

Table 4 demonstrated that the obtained sig (2-tailed) value is less than 0.05. This result demonstrated that students who learned using virtual reality media and students who learned using conventional learning methods had different average geometric abilities. Table 5 shows significant geometric ability.

Table 5. Mean Scores of Experimental Class Post-test and Control Class Post-test

	Class	N	Mean	Std. Deviation	Std. Error Mean
The Geometric Skill	Experimental class Post-Test	100	86.05	5.299	0.430
	Control class Post-Test Class	100	52.59	1.256	0.028

Table 5 showed that children in elementary schools who learned using virtual reality received higher geometric ability average scores than students who learned using traditional methods. This result demonstrated the successful use of virtual reality media to enhance primary school kids' geometric skills.

Discussion

From the overall data analysis results, it is stated that virtual reality can improve the geometric abilities of elementary school students. The increase in the geometric abilities of elementary school students is due to the use of virtual reality media. Virtual reality provides an interactive and in-depth experience for students to understand geometric concepts. Through virtual reality headsets and 3D simulation environments, students can interact directly with geometric objects and explore geometric spaces more realistically. This media helps students visualize and understand geometric concepts better than just going through a 2D image or representation. This fact is in line with the opinion which states that virtual reality can make the learning process easier for students to understand the material and be interactive (Rohmah & Bukhori, 2020). In addition, using virtual reality in geometry can make learning more interesting and fun for students. They can engage in interactive activities, such as building and manipulating geometric objects, exploring geometric spaces virtually, and solving geometry problems in immersive environments. This media can increase students' motivation and interest them in learning geometry. This fact is supported by the results of previous study which state that learning using virtual reality media is fun learning (Bower et al., 2015).

Geometry involves understanding form, space, and the relationships between objects in space. Virtual reality can help develop students' spatial skills, namely the ability to understand, visualize, and manipulate objects in space. Through interactive virtual reality experiences, students can practice their spatial skills in a practical and hands-on way. This fact is supported by the results of research which states that virtual reality can improve students' spatial abilities (Renganayagalu et al., 2021). Virtual reality also allows students to experience real contexts within a geometric environment. They can explore geometric objects at a suitable scale and observe the relationships between these objects in a realistic virtual environment. This media helps students understand geometry in everyday contexts and see the relevance of geometric concepts to the real world. This result is in line with the research results which state that virtual reality can present the context of everyday life in 3/2 dimensions (Demitriadou et al., 2020). This fact makes the use of virtual reality media able to improve the geometric abilities of elementary school students.

The results of this study become new findings. This fact can be seen in previous studies. The findings of previous study which claimed that the creation of a virtual reality-based math education system employing GIS technology was able to deliver interactive and realistic learning content, validated the conclusions of this study (Xie et al., 2019). According to this study, virtual reality technology might help kids become more motivated and interested in math. GIS data also allowed pupils to visualize and interact with complex math concepts. Previous research led to creation of a virtual reality-based math learning application that could aid students in visualizing and actively engaging with arithmetic subjects (Elsayed & Al-Najrani, 2021). According to the study, students could benefit from using the application to understand better the mathematical concepts being taught. The goal of other study was to assess how using virtual reality games could increase student achievement and engagement in mathematics classes in elementary schools (Akman & Çakır, 2020). Results revealed that students who learned through virtual reality math games performed higher on the achievement test than students who used conventional learning methods. Additionally, the experimental group saw increased students' motivation to learn. According to the findings of this study, using virtual reality could assist primary school pupils in grasping mathematics better. Additionally, incorporating virtual reality into elementary school mathematics learning could boost students' interest and learning motivation. From the research that other researchers have conducted, virtual reality media can increase learning motivation, interest in learning, understanding of concepts,

achievement and student activity in the learning process. A new finding found in this research is that virtual reality can improve the geometric abilities of elementary school students.

The ability to grasp and apply geometry concepts, such as recognizing shapes, calculating angles and distances, and solving geometry-related issues, is known as geometric ability. One of the critical components of studying mathematics is the geometric ability, which was typically taught in mathematics classes at school. Understanding and using geometry concepts like measurement, comparison, symmetry, transformation, and other related ideas was known as geometric ability. Applying geometry was crucial since it was relevant to many aspects of life, including science, technology, and mathematics (Buckley et al., 2019; Kurbonov & Istamova, 2021). Geometric ability can also assist pupils in problem-solving, critical thinking, and the growth of their creativity. Due to the prevalence of geometry in nature and daily life, geometric skills can also aid pupils in developing a deeper understanding of their surroundings (Fougnie et al., 2020; Wahyuni et al., 2020). Therefore, enhancing pupils' geometric ability could have a significant positive impact on both their academic and psychological growth.

According to these results, using virtual reality learning resources could help primary school pupils' geometric skills. Through a headset or other virtual reality devices, users of virtual reality technology could experience a virtual world that resembles the actual world. Users could engage in realistic and in-depth interactions with items and environments in a virtual setting (Ayoub & Pulijala, 2019; Zhan et al., 2020). Virtual reality in primary classrooms continued to be a hot topic of discussion. Therefore, further research into the application of virtual reality and its effects on learning was still necessary. The results indicated that using virtual reality in elementary classrooms might improve pupils' geometrical skills. Virtual reality is a technology that gives people the impression that they are in a technologically advanced environment. Users might engage with the virtual environment and experience its sensations. For primary school pupils, virtual reality could offer a more engaging and immersive educational experience (Kaplan et al., 2021; Shahroom & Hussin, 2018). Virtual reality might help students become more proficient in geometric concepts since it could make learning more engaging and realistic. Students could more easily visualize things and three-dimensional space in a virtual reality environment, which could improve their understanding of geometric concepts. Additionally, using virtual reality could present students with more difficulties and simulations, which could aid in developing the problem-solving and critical thinking skills necessary for studying geometry.

Additionally, virtual reality might offer a more comprehensive and authentic experience in exploring objects and space, enhancing students' general comprehension. Students might benefit from an immersive and engaging learning environment provided by virtual reality. Using virtual reality in geometry education could give students a more tangible and visual understanding of geometry concepts, improving their comprehension and ability to master geometry material. Students might experience a three-dimensionally generated geometry world in virtual reality, allowing them to see, feel, and explore geometry objects in a way that was not possible with traditional learning materials like books or photographs. Students' motivation and interest in learning geometry might be increased by using virtual reality to present them with more enjoyable and stimulating tasks and interactions. Because they would feel more engaged and immersed in a dynamic and enjoyable learning process, the use of virtual reality in geometry lessons was also able to enhance students' enthusiasm to study. Students felt more involved in the learning process. They developed a greater interest in mathematics and geometry because they could conduct explorations and experiments in virtual environments that were impossible to achieve in traditional learning. Virtual reality technology might benefit pupils in comprehending geometry concepts that were abstract and challenging to grasp through traditional media like books and images. Virtual reality learning resources contribute to primary school pupils' geometric skills improvement. So this study states that the use of virtual reality learning media increases elementary school students' geometric abilities.

4. CONCLUSION

The results of measurement and analysis stated that there were differences in the geometric thinking ability scores of elementary school students before and after using virtual reality. The findings also state that there is a difference in the average geometric ability of students who learn using virtual reality media and students who learn using conventional learning, where the average value of the geometric abilities of elementary school students who learn to use virtual reality gets a higher score compared to other students. Who learn to use conventional learning. This result proves that using virtual reality media effectively improves the geometric abilities of elementary school students.

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