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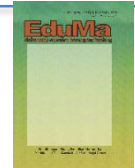
Improving Geometry Thinking Ability through Augmented Reality Based Learning Media

Nurbaiti Widyasari[1*], Lulu Irianti Mastura[2]

[1,2]Program Studi PGSD, Universitas Muhammadiyah Jakarta, DKI Jakarta, 15419, Indonesia

[*]Corresponding author:Universitas Muhammadiyah Jakarta

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a b s t r a c t

IMPROVING GEOMETRY THINKING ABILITY THROUGH AUGMENTED REALITY BASED LEARNING MEDIA. This study aims to improve students' geometrical thinking skills through the media of Augmented Reality learning. Augmented Reality learning media is a learning medium that combines a real object with a virtual object that has a 3-dimensional (3D) shape and is designed to resemble the actual environment that aims to provide an information to its users with an interesting, interactive, and real-time delivery. This study is a quasi-experimental or quasi-experimental study with the design used by researchers, namely the nonequivalent control group design. The population in this study were 202 students of class V SDN Cireundeu 01. The sample of this research was 52 students consisting of 26 experimental class students and 26 control class students who were determined through purposive sampling technique. The instrument used in this study was in the form of a geometric thinking ability test. Data analysis of students' geometry thinking skills was done by t-test using SPSS 16. The results of the analysis showed that the thinking ability of students in geometry taught using Augmented Reality learning media was higher than students who were taught using concrete media. Therefore the results of this study indicate that mathematics learning by using Augmented Reality learning media has a significant role in increasing students' geometrical thinking abilities.

K e y w o r d s :
Geometry Thinking; Learning Media; Augmented Reality

INTRODUCTION

Every level of normal education, both in elementary, junior high, high school, also university there are mathematics subjects that are considered important subjects. This is because through mathematics, students are trained to be able to think, analyze, and solve a problem.

The materials in mathematics are arranged in such a way as to improve a student's thinking ability. Geometry material can be said to be one of the materials that are widely studied in mathematics in schools. Furthermore, in the tests conducted by TIMSS in 2015, geometry obtained a third of the mathematical content in the test. So geometry is important to learn. In fact, the importance of students' geometrical thinking skills is not in line with conditions in the field. This can be seen from the results of research on Van Hiele geometry levels in all grade 4 in SDN 3 Parepare area in the 2016/2017 school year showing most students at Level 0 and Level 1, out of a maximum score of 25, only 7 average scores produced by respondents, where these conditions are included in the category of thinking geometry is very low (Zainal, 2017).

Many factors cause the low ability of students to think geometry, including teaching factors, learning techniques, and the media used by teachers. But mostly caused by the media. Teachers who deliver material using learning media that is adapted to the material can make each learning process that goes on it becomes better (Rahmani & Widyasari, 2018). This is because the media has an important role in the learning process. However, with the development of technology today, concrete media are considered less effective and efficient.

Many applications in the world of technology can be utilized in current technology-adjusted learning activities. One of them is the use of the AR application. Augmented Reality / AR application is an application that unites elements in cyberspace such as 2D or 3D objects in real life.

LITERATURE REVIEW
Geometry thinking

Thinking is a problem or situation that must be solved by someone with mental activities owned (Karim, 2014). Agree with the previous case, thinking means the process that is done by the brain to find answers, ideas or problems (Ananda, Fauzi & Yamin, 2018). Based on some of the previous theories, it can be concluded that the ability to think is a person's ability to face and solve a problem that is done with the brain to find answers and ideas from these problems.

Geometry can be interpreted as a science of measurement (Moeharti in Hanafi, 2017). Furthermore, geometry is visual patterns that are presented with non-physical phenomena that will be linked to the real world and include the part of mathematics that is studied (Hanafi, 2017). Agree with the previous case, through geometry can understand everything in the world both about the shape and nature (Asis, Arsyad & Alimuddin, 2015). Based on several theories presented previously, the ability to think geometry can be concluded is the ability of a person to do with his brain to solve a problem of geometry about non-physical phenomena that will be linked to the real world so that they can understand all forms in the world.

Van Hiele argues that a person will pass through hierarchical levels of thinking in studying geometry (Ikhsan, 2008) in (Safrina, Ikhsan, & Ahmad, 2014). Furthermore, Van Hiele explained that there are levels of understanding of spatial ideas with each level describing one's thought processes and ideas about geometry, (Van De Wale, 2008) in (Sumarah, Aprinastuti, & Anggadewi, 2017). The following levels compiled by Van Hiele include:

1) Visualisasi (Level 0)

Namely students view spatial as something around them. Students recognize geometric shapes from their outer forms, students are not yet aware of the properties contained in them, so the role of "form or appearance" of geometric shapes becomes very dominant at this level. In fact, the appearance / appearance of the shapes can determine the properties of a structure. Lower grade elementary school students are usually at this level.

2) Analisis (Level 1)

Namely students begin to be able to analyze concepts, for example by observation, students can determine the characteristics of an image. Students at this level understand that a picture always has a part and that the picture is known by its part. Although students already know the properties of a building, but at level 1 they have not been able to determine the relationship of one building to another with its nature, and have not been able to understand the relationship between the definition of the shapes. Usually elementary students who are at this level.

3) Deduksi Informal (Level 2)

Namely students can build relationships between waking up or interrelated images. For example it can be said that a square is equal to a rectangle because it has right angles and the sides are parallel. At this level students can already know the definitions provided but cannot yet understand the significant deduction regarding the axiom flow. Formally the evidence can be understood, but logical reasoning is still difficult to draw even if it is not visible how a proof can be built from different statements.

4) Deduksi (Level 3)

This level students are able to understand geometrical theories axiomatically. The interrelationship of parts, axioms, postulates, definitions, theorems and proofs can already be seen. Students who are at this level not only remember, but can already build, prove, and even make it possible to develop evidence in more ways than one. In addition, students are also able to build interactions from objects that are needed and understand the conditions needed, and are able to make a difference between statements and expressions. This level is usually reached by middle and upper level students.

5) Ketepatan (Level 4)

Namely students can analyze more complex axiom systems including abstract geometry. Students can already compare differences in axiom systems. This level is usually achieved by students who study the field of geometry in greater depth.

Learning Media *Augmented Reality*
Learning media are all student stimuli in the learning process used to channel messages, so that the goals of learning can be achieved (Daryanto, 2016). Then, Azuma (1997) argues that Augmented Reality (AR) is 3D animation, is interactive in real time, and is a combination of the real world with virtual (Nugroho & Ramadhani, 2015).

Meanwhile, there are advantages and disadvantages of Augmented Reality (Mustaqim & Kurniawan, 2017). The advantages of AR are:

1) Interactive.
2) Effective.
3) Can be implemented in a wide variety of media.
4) Modeling of objects is displayed simply.
5) Does not require a lot of cost in making.
6) Operation is quite easy.

Furthermore, the shortcomings of Augmented Reality are as follows:
1) In terms of changes in perspective it is more sensitive.
2) Not too many manufacture yet.
3) Installed equipment requires a lot of memory.

METHODOLOGY

a. Population and Sample

All fifth grade students of SD Cireundeu 01, semester II 2018/2019, with 202 students in their population. V-B students 26 people and V-F 26 people so that the total number of samples to be used by researchers is 52 people.

b. Research design

This research uses experimental quantitative. Quasi-experimental type or quasi experimental designs. Quasi-experimental design conducted by researchers is the nonequivalent control group design.

c. Data Processing Flowchart

The instrument was in the form of a matter of thinking ability in the form of multiple choice geometry of 10 questions. In addition, there are supporting data prepared by researchers such as lesson plans, teaching materials (LKS), and student and teacher activity sheets. Increased geometry thinking skills can be known by looking for normalized gain values adopted from (Hake, 1999). Next, use the t test to analyze data, as well as test other statistical assumptions.

RESULTS AND DISCUSSION

a. Description of Test Results

The geometric thinking ability test that is applied is pretest and posttest which is done in VB class also in VF class. There are two levels of the ability to think geometry, namely 5 items at the level of visualization and 5 items at the level of analysis of the 10 items given. The result data is in the table below:

Table 1
Average Pretest, Posttes, and N-Gain Scores of Geometry Thinking Ability in the Control Class and Experiment Classn

Class	$\overline{X}_{Pretest}$	$\overline{X}_{Posttest}$	$\overline{X}_{N\text{-}Gain}$
Eksperimen (VB)	54,23	83,84	0,65
Kontrol (VF)	58,07	65,38	0,17

To see an increase in the ability to think geometry used normalized data gain (N-Gain) which was tested using the t test. The following is the result data:

Table 2
Test of Geometry Thinking Ability

N-Gain Result	Levene's Test for Equality of Variances		t-test for Equality of Means			Hipotesis	Decision
	F	Sig.	t	df	Sig. (2-tailed)		
Equal variances assumed	0,451	0,505	8.434	50	0,000	H0 Declined	Differencing detected
Equal variances not assumed			8.434	47.328	0,000		

Based on Table 2, the t-test value of 8,434 and 0,000 of the significance value stated that H0 was rejected H1 was accepted, which means that the geometrical thinking ability of students who used AR media was different from those using concrete media.

CONCLUSIONS AND RECOMMENDATIONS

a. Conclusion

The author gets the conclusion that there are differences in the ability to think geometry of students who use Augmented Reality media better than concrete media. Based on the t test the difference is 8.434.

b. Recommendation

The author has several suggestions: (1) The teacher in applying AR media in class must prepare an application that is already installed on the mobile and Augmented Reality Mathematics marker in advance. (2) When using this learning media students must correctly point the camera to the images contained in the Augmented Reality Math Markers so that students can use this Augmented Reality learning media correctly and get the desired information not only in classroom learning. (3) Schools can apply evenly this Augmented Reality learning media in other V grades, not only in the class that is used in research that knows and applies this Augmented Reality media so that it can improve the ability to think geometry in all grade V. (4) Researchers it is also expected to further develop Augmented Reality learning media so that it is more animated when used by students. It is also expected to be able to apply Augmented Reality learning media to improve other mathematical thinking abilities by adding learning methods that have not been used by teachers when using this Augmented Reality learning media, such as for example no longer using lecture, question and answer, and demonstration methods.

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