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| D:\Eduma Jurnal\logo eduma\logo Eduma.png | **Published by** **Tadris Matematika****IAIN Syekh Nurjati Cirebon** |

**EduMa: Mathematics Education Learning And Teaching December 2019, Vol 8 No 2 Page xxx – xxx**

<https://syekhnurjati.ac.id/jurnal/index.php/eduma/index>

**p-ISSN: 2086-3918, e-ISSN: 2502-5209**

**EduMa**

**MATHEMATICS EDUCATION LEARNING AND TEACHING**

 article link: https://syekhnurjati.ac.id/jurnal/index.php/eduma/eduma/article/view/xxxx

article link in journal

**Augmented Reality: Enchanching Van Hiele’s Geometry Thinking in Level 0 and 1**

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| **a r t i c l e i n f o**  |  | **a b s t r a c t** |
| Widyasari, Nurbaiti., Mastura, Lulu Irianti. (2019). Augmented Reality: Enchanching Van Hiele’s Geometry Thinking in Level 0 and 1. Eduma : Mathematics Education Learning And Teaching, 8(1), 1 - 10.Article history:Received: MM DD, YYAccepted: MM DD, YYPublished: MM, YYCopyright © 2019 by author (s) and EduMa: Mathematics Education Learning and Teaching under the [Creative Commons Attribution-ShareAlike 4.0 International License](http://creativecommons.org/licenses/by-sa/4.0/)**.**  |  | The aim of this research is improving students' geometrical thinking skills through the media of Augmented Reality learning. The research utilized a quasi-experimental with the nonequivalent control group design. The population in this study are 202 students of fifth grade from one of the elementary school in South Tangerang. The sample of this research is 52 students who were determined through a purposive sampling technique. The instrument used in this research was a geometric thinking ability test. Data analysis of students' geometry thinking skills was done by t-test. The results of the analysis showed that the thinking ability of students in geometry’s level 0 and 1 that 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 particularly in levels 0 and 1.*Keywords: Geometry Thinking Ability, Learning Media Augmented Reality, Concrete Objects* |
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**INTRODUCTION**

 Every level of normal education, both in elementary, junior high, high school, as well as universities that provide mathematics lessons. This is because, through mathematics, students are drilled to be able to think, analyze, and solve problems.

 The materials in mathematics are arranged to improve students' thinking abilities. Geometry material can answer one material that is widely studied in mathematics in school. Furthermore, in tests conducted by TIMSS in 2015, geometry obtained a third of the mathematical content in the test. So geometry is important to learn. On agreement, the importance of students' geometrical thinking abilities does not match conditions in the field. This can be seen from the results of research on Van Hiele geometry levels in all 4 grades in SDN 3 in the Parepare area in the 2016/2017 school year that discusses students at Level 0 and Level 1, from a maximum score of 25, only 7 average scores produced by respondents, Where these conditions are included in the category of geometry thinking is very low (Zainal, 2017).

 Many factors cause low students' geometry thinking skills, but the factors that influence are learning, and the media used by the teacher. But mostly caused by the media. Teachers who deliver material using learning media that are tailored to the material can make every learning process better (Rahmani & Widyasari, 2018). This is because the media has an important role in the learning process. However, with the development of current technology, the media are considered less effective and efficient.

Many applications in the world of technology can be used 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 not in the virtual world like 2D or 3D objects in real life.

LITERATURE REVIEW/ THEORETICAL FRAMEWORKS (IF APPLICABLE)

**Geometry Thinking**

 Thinking is a problem or situation that must be solved by someone with mental activities they have (Karim, 2014). Agree with the previous case, thinking means the process that is done by the brain to find answers, ideas or problems (Ananda & 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 associated with the real world and include the mathematics studied (Hanafi, 2017). In line with the previous case, the topic of geometry can understand everything in the world both form 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 work with his brain to solve a problem of geometry about non-physical phenomena that will be connected with 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 (Safina, 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. Visualization (Level 0)

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

1. Analysis (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 images always have parts and that they are known by their parts. Although students already know the properties of a building, unfortunately 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 are at this level.

1. Informal Deduction (Level 2)

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

1. Deduction (Level 3)

 In this level, students can understand the theory of geometry 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. Furthermore, students are also able to build interactions from what objects are needed and understand the conditions needed and can make a difference between statement and expression. This level is usually reached by middle and upper-level students.

1. Accuracy (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.

**Augmented Reality Learning Media**

 Learning media are all student stimuli in the learning process used to channel messages so that the objectives 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 a 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. It can be implemented in a wide variety of media.
4. The modeling of objects is displayed simply.
5. It does not require a lot of cost in making.
6. The 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 manufactures yet.
3. Installed equipment requires a lot of memory.

METHODS

1. 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 the total number of samples to be used by researchers are 52 people.

1. Research design

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

1. 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. Besides, there are supporting data prepared by researchers such as lesson plans, teaching materials (LKS), and student and teacher activity sheets. Increased geometry thinking ability 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.

RESULT AND DISCUSSION

1. 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 resulting data is in the table below:

**Table 1. Average Pretest, Posttest, and N-Gain Scores of Geometry Thinking**

**Ability in the Control Class and Experiment Class**

|  |  |  |  |
| --- | --- | --- | --- |
| **Class** | $\overbar{X}$ ***Pretest*** | $\overbar{X}$ ***Posttest*** | $\overbar{X}$**N-Gain Score** |
| **Experiment (VB)** | 54,23 | 83,84 | 0,65 |
| **Control (VF)** | 58,07 | 65,38 | 0,17 |

1. Data analysis

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

**Table 2. Test of Geometry Thinking Ability**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| N-Gain Results | Levene’s Test for Equality of Variances | t-test for Equality of Means | Hypothesis | Decision |
| F | Sig. | t | df | Sig. (2-tailed) | H0 rejected | There are differences |
| Equal variances assumed | 0,451 | 0,505 | 8.434 | 50 | 0,000 |
| Equal variances not assumed |  |  | 8.434 | 47.328 | 0,000 |

Based on Table 2, the t-test values ​​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 use AR media is different from those using concrete media.

CONCLUSION AND IMPLICATION

* 1. Conclusion

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

1. Implication

 The author has several suggestions: (1) The teacher in implementing 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 at the images in the Augmented Reality Math marker so 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 class V, 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 skills by adding learning methods that have not been used by teachers when using this Augmented Reality learning media, such as no longer using lecture, question and answer, and demonstration methods.

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