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Development of *Geogebra* Learning Media on Realistic Approach to Improve Spatial Ability Student

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Abstract This study aims to analyze the effectiveness of learning media using a *Geogebra*-assisted realistic approach to improve the mathematical spatial abilities of junior high school students. This type of research is a research development using a modification of the development model of Thiagarajan, Semmel and Semmel (1974). The stages of this research are define, design, develop, and disseminate. In this study compiled learning tools and instruments, namely: RPP, LAS, *geogebra*-assisted learning media, spatial ability tests. Try out conducted at student of class VIII-7 as much 40 people and VIII-6 as much people at MTsN 2 Medan. The results showed that learning media using a *Geogebra*-assisted realistic approach met the effective criteria of completeness spatial ability reaching 87.5% and learning time not much different from the usual learning time.

Keywords: *development of instructional media, realistic approach, geogebra, spatial ability*

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1. Introduction

Improving learning outcomes, as planned, requires an improved learning process [1]. Media can be interpreted as an intermediary or messenger message from educators to students. Learning media have a big role in determining learning outcomes. This is in accordance with research [2] multimedia learning is able to simplify complex material into simple, visualizing abstract events into concrete helps students more easily understand the material so that it can improve learning outcomes. Multimedia learning presents teaching materials in the form of text, visuals, graphics, animation and video (movie) can arouse student motivation to improve learning outcomes [3].

Spatial thinking is a collection of cognitive skills, which consists of a combination of three components, namely the concept of space, a tool of representation, and the process of reasoning [4]. Components of spatial thinking include spatial visualization, spatial perception, spatial orientation, spatial rotation, spatial relations [5]. [6] argues that spatial ability is the ability that involves discovery, retention and visual transformation in the context of space

[7] who found that spatial ability was a major intelligence factor that was not only important for mathematics and science, but also needed for success in many professions. Spatial skills are needed to solve problems in several fields of study such as computer graphics, engineering and architecture [8], industrial technology [9] and astronomy, education, geography, geosciences and psychology [4].

The PISA survey results in 2012 showed that Indonesian students were weak in Space and Shape content, answering 69.2% (OECD average 25.8%) at level one, 19.8% (average 22.3%) on level two, 7.8% (average OECD 22.2%) at level three, 0% (average 29.7%) at high level (National Center for Education Statistics USA, 2014). This is also consistent with research [10] and [11] which states that the spatial ability of students in Indonesia is still very weak.

Geogebra is a dynamic mathematics learning software developed by Markus Hohenwarter for learning mathematics in schools. *Geogebra* is freely and widely available on the internet from the webpage www.GeoGebra.org for various types of operating systems. According to [12] states that *Geogebra* software can help teachers to convey abstract mathematical material to be more easily understood because geogebra can visualize it in addition to that *Geogebra* can also train students' creativity and critical power. [13] stated that *Geogebra* can provide students with various levels of visualization skills to learn geometric concepts and to explore relationships easily.

[14] in his research results in Medan city junior high school said that the spatial ability of students who were taught using a realistic approach was better than the spatial abilities of students who were taught with conventional approaches. [15] in their research in high school with students' realistic approaches more active than using conventional approaches. [16] stated in their research that students who are taught with a realistic approach are much higher in learning outcomes than with conventional learning

2. Method

This research includes development research (Development Research) using the [17] development model which consists of 4 stages namely define, design, develop and disseminate. In this study, developed in the form of learning media using a realistic approach assisted by *Geogebra*.

This research was conducted in MTsN 2 Medan class VIII in the even semester of the 2018/2019 school year with the first trial conducted in class VIII-7 and the second trial conducted in class VIII-6 on cube and beam material. The instrument used was a spatial ability test.

Data Analysis Techniques for Learning Media Effective

1. Achievement of Student Learning Completeness

In this study, student learning outcomes are viewed from their spatial ability using spatial ability tests. This test is given at the end of each learning meeting, to find out how the level of mastery and completeness of students on the material they have learned.

The effectiveness of learning devices related to students 'mathematical spatial ability is determined based on the achievement of students' mastery learning classically. According to [22] based on the KTSP provisions the determination of the learning provisions is determined solely by each school known as the minimum completeness criteria (KKM), based on three considerations, namely: the ability of each learner to differ, the facilities (facilities) each school is different and the carrying capacity of each student is different. So in this study, according to the KKM in the school where the researcher conducted the research, the individual completeness was 70 and classical completeness was 85%.

Based on the explanation above, to find out the percentage of students' abilities obtained each cycle used the formula:

$$\text{Final Score} = \frac{\text{student score}}{\text{total score}} \text{x100.}$$

To see the completeness classically used the formula:

$$\text{Classical completeness} = \frac{\text{number of students who have finished learning}}{\text{number of research subjects}} \times 100\%.$$

The action is considered successful if classically at least 85% of students complete. If it is less than 85%, the action is deemed unsuccessful then retrying.

2. Time Achievement Data Analysis

This data is obtained by looking at the achievement of the time used in the learning process. If the achievement of the time spent during learning is less or equal to the usual learning time, the achievement of time is said to be good.

To analyze the improvement of students' mathematical spatial ability, data were obtained from the results of students' pre-test and post-test. Increasing students' mathematical spatial ability can be obtained from normalized gain index data Hake (1999), as follows:

$$N - gain = \frac{posttestvalue - pretestvalue}{idealvalue - pretestvalue}.$$

Table 1. Gain Score

Gain Score	Category
g > 0.7	High
0.3< g ≤ 0.7	Medium
g ≤ 0.3	Low

3. Result

3.1. The Description of Learning Media Development Stage

In this study, learning media met the effective criteria in trial II or in other words, the draft final was obtained in trial II. The results of the development of learning media using the Thiagarajan 4-D model are explained as follows:

3.1.1. Define

Based on interviews with grade VII mathematics teachers at MTsN 2 Medan, information was obtained that the target students in class VIII were students who were quite heterogeneous, both in terms of their sex and their cognitive abilities. Furthermore, the learning process in the classroom using only printed books as the only source of learning was felt to be very unfortunate given the adequate school facilities. The problem that arises is the absence of adequate learning media to explain a concept outside of practicum.

3.1.2. Design

At this stage an initial draft of the lesson plan is produced for 6 meetings student worksheet, media assisted by *Geogebra* and spatial ability test. All results at this design stage are called draft I.

3.1.3. Develop

At this stage validates draft I to experts and then conduct field trials. The aim is to see weaknesses in draft I so that it can be revised and refine the learning material developed. Based on the calculation, the reliability of the mathematical spatial ability test is 0.77 (very high category).

After the learning device developed has fulfilled the valid criteria, then the learning device in the form of draft II is tested at the research site in MTsN 2 Medan as a trial I. Based on the results of the data analysis trial, it was found that the learning device developed did not meet all the effective criteria, so that improvements are made to produce learning materials that meet all the effective criteria set. The revision is based on the findings of the weaknesses of the learning device in the trial I, namely for the learning implementation plan related to the allocation of learning time, as well as the student books and worksheets related to the material being taught. After the revision was completed, the second trial was conducted to produce learning materials that met good effectiveness and increased mathematical spatial ability.

3.1.4. Disseminate

The development of learning media reaches the final stage if it has obtained positive ratings from experts and through development tests. Then learning media are then packaged, distributed and determined for a wider scale. But in this study the disseminate stage was not carried out, so the fourth stage was not explained.

3.2. Trial

3.2.1. Trial 1

The validity of Geogebra-assisted mathematics learning media developed is seen from the assessment of media experts and learning material experts meeting the minimum valid criteria, where the results say that the developed learning media is declared valid with an average value of for learning media experts and for learning material experts to be clearer , consider this Table 2.

Table 2. Results of Learning Media Validation by Experts

Validator	Average Score	Criteria
Mathematics Learning Media Expert	4,36	Valid
Mathematics Learning Learning Material	4,33	Valid

Based on the data in Table 2, the interpretations of each media expert and expert in learning mathematics are in the Valid category. Thus, *Geogebra*-assisted learning media can be said to be feasible to use.

Effectiveness of *Geogebra* Assisted Mathematics Learning Media Developed in Trial I

1. Classical Learning Completeness of Students in Trial I

The spatial mathematical ability test is done once at the beginning before learning activities are called Pre-Test and once at the end of learning after carrying out three teaching and learning meetings called the Post-Test. Giving Pre-Test and Post-Test aims to find out the increase in mathematical spatial abilities obtained by students after being given learning treatment using *Geogebra*-assisted media using a realistic approach to cube and beam material. The data from the field trial results for mathematical spatial ability are presented in Table 3 as follows

Table 3 Completeness Level Pre-Test and Post-Test Mathematical Spatial Ability of Students in Trial I

Category	***Pre-Test***	Percentage of pre test spatial ability	***Post-Test***	Percentage of postest spatial ability
	Number Of Student		**Number of Student**	
Complete	10	25 %	26	65%
Not complete	30	75%	14	35 %
Sum	40	100 %	40	100 %
Average Class	55		74,67	

In general, bar charts describing pre-test class average, post-test mathematical spatial ability in trial I are presented in the following Figure 1.

From Figure 1, the diagram can be seen that the average class of students 'mathematical spatial abilities in the pre-test I trial was 55 while the average class of students' spatial mathematical abilities in the post-test I trial was 74.67. The following is a bar diagram of the classical completeness of students' mathematical spatial abilities in trial I.

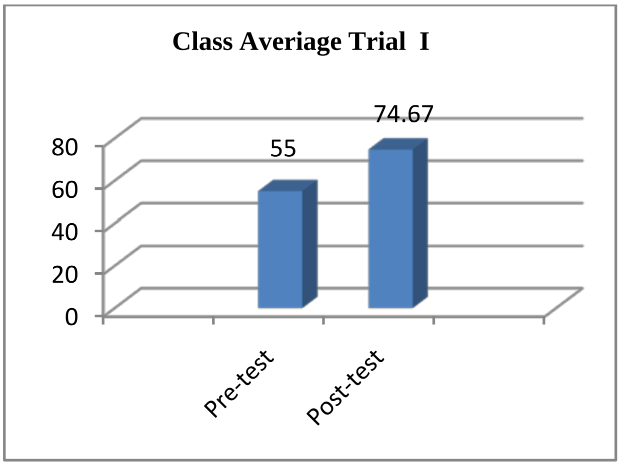

Figure 1. Class Average Trial I

2. Trial Learning Time Achievement I

Based on research that has been done on the Occa I test in the MTsN 2 Medan class, the use of time to teach cube and beam material using *Geogebra*-assisted media is in accordance with the learning implementation plan made by researchers, namely the learning time carried out the same as the learning time as usual, so it can be said that research using *Geogebra*-assisted mathematics learning media that has been developed has a good time achievement.

Increased mathematical spatial ability in the first trial will be seen through the N-Gain from the results of the pre-test and post-test mathematical spatial ability in the first trial.

Table 4. Summary of N-Gain Results for Mathematical Spatial Capability Test I

N-Gain	Interpretasi	Total Student
$g > 0,7$	High	5
$0,3 < g \leq 0,7$	Medium	23
$g \leq 0,3$	Low	12

Based on Table 4 it can be seen that 5 students got an N-Gain score in the range> 0.7 or experienced an increase in mathematical spatial ability in the "High" category. For students who experienced an increase in mathematical spatial ability with the category "Medium" or received an N-Gain score of 0.3 <g ≤ 0.7 totaling 23 people and 12 people who received an N-Gain score of g ≤ 0.3 or experienced an increase in mathematical spatial abilities with the "Low" category.

3.2.2. Trial II

Description of the Effectiveness of *Geogebra*-Assisted Mathematics Learning Media Developed in Trials II

1. Classical Learning Completeness of Students in Trial II

The spatial mathematical ability test is done once at the beginning before learning activities are called Pre-Test and once at the end of learning after carrying out three teaching and learning meetings called the Post-Test. Giving Pre-Test and Post-Test aims to find out the increase in mathematical spatial abilities obtained by students after being given learning treatment using Geogebra-assisted media using a realistic approach to cube and beam material. The data from the field trial results for mathematical spatial ability can be seen in Table 5

Table 5. Completeness Level Pre-Test and Post-Test Mathematical Spatial Ability of Students in Trial II

Category	*Pre-Test* Number Of Student	Percentage of pre test spatial ability	*Post-Test* Number of Student	Percentage of postest spatial ability
Complete	11	27,5 %	35	87,5%
Not complete	29	72,5%	5	22,5 %
Sum	40	100 %	40	100 %
Average Class	51,83		83,83	

In general, bar charts describing the pre-test class average, post-test mathematical spatial ability in trial II are presented in the following figure:

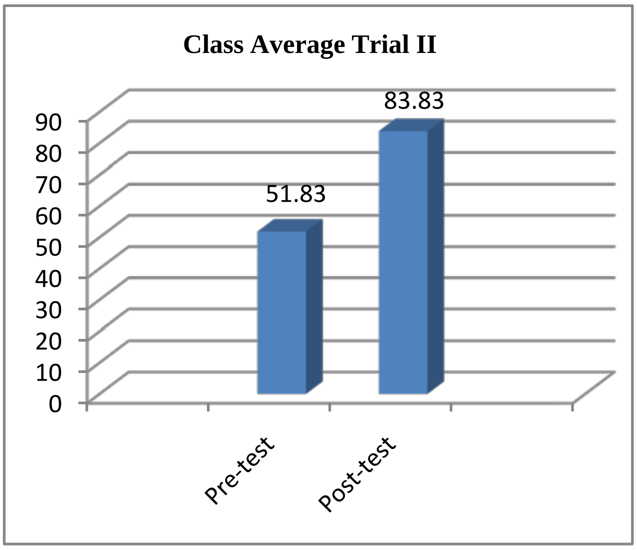

Figure 2. Class Average Trial II

From picture 2 can be seen that the average class of students 'mathematical spatial abilities in the pre-test II try out was 51.83 while the average class of students' mathematical spatial abilities in the post-test II try out was 83.83.

From Table 5 it can be seen that the classical completeness of students 'mathematical spatial ability in the pre-test II trial is 27.5% while the classical completeness of students' mathematical spatial ability in the post-test II trial is 87.5%. In accordance with the criteria of completeness of student learning classically, i.e. a minimum of 85% of students who take the students' spatial ability test are not yet classically complete. So it can be concluded that in the second trial the application of *Geogebra*-assisted learning media that was developed fulfilled the classical achievement completeness criteria.

Increased mathematical spatial ability in the second trial will be seen through the N-Gain from the results of the pre-test and post-test mathematical spatial abilities in the second trial.

Based on Table 6 it can be seen that 18 students received N-Gain scores in the range> 0.7 or experienced an increase in mathematical spatial abilities in the "High" category. For students who experienced an increase in mathematical spatial abilities in the "Medium" category or received an N-Gain score of 0.3 <g ≤ 0.7, there were 22 people.

Table 6. Summary of N-Gain Results for Mathematical Spatial Capability Test II

N-Gain	Interpretasi	Total Student
g > 0,7	High	22
0,3 < g ≤ 0,7	Medium	8
g ≤ 0,3	Low	0

4. Discussion

Based on the results of the analysis in trials I and II it was found that the spatial ability of sisea had met the classical completeness criteria. This is due to the material and problems that exist in the mathematics learning media developed from student activity sheets in accordance with the conditions of the student learning environment. By using instructional media in the classroom, students will better understand all forms of building cubes and blocks, because as explained by [18] which says that learning media can overcome the limitations of the senses, space and time. For example, by using learning media students do not need to imagine objects in the shape of cubes and blocks, because these objects can be visualized using learning media, so students can see firsthand how the shapes of the objects are. This is in line with research [19] also revealed that learning by using multimedia is able to solve problems related to daily life that can improve students' spatial abilities.

The mathematical spatial ability of students can be increased due to *geogebra*-assisted learning media that is applied to students who have met the criteria of good learning media quality, with good learning media used and with the application of learning models of *Geogebra*-assisted realistic approaches to learning, the students' mathematical spatial ability increases.

Likewise mentioned in the research [20] states that the spatial ability of students who are taught using learning media is better than students who are taught without using learning media. The same thing was also expressed in [21] which states that learning using media can improve students' spatial abilities. In line with the study, the results of [14] study stated that using instructional media can improve students' spatial abilities at school. This means that using learning media when the teaching and learning process takes place can improve students' spatial abilities. Based on the results of research that has been done also based on previous studies can be submitted that the *Geogebra*-assisted mathematical learning media developed positis positive impact on students' spatial ability.

5. Conclusion

The results showed that learning media using a *Geogebra*-assisted realistic approach met the effective criteria of completeness spatial ability reaching 87.5% and learning time not much different from the usual learning time.

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