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APPLICATION OF GEOGEBRA APPLICATION TO STUDENTS' GEOMETRIC THINKING SKILLS AND LEARNING INTERESTS THROUGH A PROJECT-BASED LEARNING MODEL

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Abstract

Mathematics is very important for understanding and problems of daily life, one of which is the branch of mathematics that studies the shape of surrounding objects is geometry. In fact, students' interest in learning and geometric thinking skills are still relatively low. The purpose of this study is to find out whether students' geometric thinking skills and students' learning interests given learning with the project based learning (PjBL) model assisted by the Geogebra application are better than those given by conventional learning. The design of this study is true experimental design the pretest posttest control group design. The sample was selected using random sampling technique. Data collection techniques by providing geometric thinking ability test questions and mathematical learning interest questionnaires to students. The data obtained was analyzed using the mean difference test. From the results of the posttest data analysis of the experimental and control classes, a sig value of 0.001 < 0.05 was obtained, which means that the geometric thinking ability of students who were given learning with the project based learning (PjBL) model assisted by the Geogebra application was better than that given by conventional learning. Furthermore, it is known that the average results of the learning interest questionnaire for students in the experimental class are 76.56 and in the control class is 59.94. So it can be concluded that the learning interest of students who use the project-based learning (PjBL) learning model assisted by the Geogebra application is better than students who use the conventional learning model.

***Keywords**: Project-based learning (PjBL); Geogebra; thinking geometry; Learning Interest.*

INTRODUCTION

Education has a very important role in daily life because the process can be found all over the world. Every level of education teaches mathematics, which is one of the subjects that is always present and mandatory for students to learn. Based on Government Regulation No. 32 of 2013 concerning national education standards, mathematics is one of the main subjects in the basic education curriculum, starting from elementary school to secondary school and other equivalent levels. To achieve national education goals, it is important to achieve a balance between cognitive, affective, and psychomotor abilities. Therefore, every subject, including mathematics, must integrate these three competencies in its learning process.

According to Van De Walle as quoted by Yuliyanti *et al* (2021), mathematics is a set of rules that need to be understood, including arithmetic calculations, complex algebraic equations, and proofs in geometry. According to Baron as quoted by Handayani (2020), emphasizes the importance of understanding symbols, images, or patterns in mathematics while learning. Effective symbolic

language, compelling regularity, and quantitative analysis capabilities in mathematics can help create the mathematical models necessary to solve a variety of problems in science and everyday life. Thus, mathematics can be considered as a science that helps in solving problems in various sciences.

Mathematics is very important for understanding and problems of daily life, therefore the learning must be packaged as best as possible to make students happy and pay full attention to the lesson. Attention will arise if there is interest. This is because the focus of earnest attention on the material allows students to be more active and understand the lesson well. In accordance with Hendriana's opinion *et at.,* (2017), Interest can encourage a person's participation in an activity. According to Sutrisno & Nurina Happy (2020), if a person has an interest in a subject, he will actively study and continue to explore all knowledge related to the field, follow lessons with enthusiasm and without feeling burdened.

If students have a low interest in mathematics, their ability in that field will be negatively affected. (Apriyanto & Her lina, 2020). With interest, students will be encouraged to take the lessons seriously from start to finish, which contributes to the achievement of good learning outcomes. As explained, students who have an interest in learning will study mathematics with full seriousness, feel happy to participate in mathematics learning activities, and be able to solve mathematics problems because of their interest in learning it. Therefore, the learning process will go more smoothly if it is accompanied by interest. This student's interest in learning will significantly affect their learning outcomes.

In line with these problems (Musa'ad *et al*., 2023), explains that the lack of interest in learning mathematics is often caused by the assumption that mathematics is an elusive subject, frightening, and uninteresting, as well as due to the use of too many numbers and formulas that must be memorized. As a result, students become less interested in learning mathematics. One branch of mathematics taught in schools is geometry, which allows many mathematical concepts to be explained or displayed through geometric representations (H. Hamidah *et al*., 2022; Hamidah & Kusuma, 2020). In addition to being able to develop logical thinking skills, geometry is also effective in solving problems in various branches of mathematics. In addition, geometry can be found in everyday life through the shapes of objects around us.

Geometry in schools plays an important role in the development of students' thinking skills in particular as well as in aspects of life in general, so it is important to teach it to students in the right way (Fatmasari *et al*., 2020). However, in fact, the ability to think about geometry in Indonesia is still relatively low (Naufal *et al*., 2021) (Hassan *et al*., 2020). In line with this based on research conducted (Rahayu *et al*., 2023) also explained that students' low geometry skills, coupled with the impact of online learning during the COVID-19 pandemic, caused difficulties in understanding geometry materials. As a result, their geometry learning results are still unsatisfactory. Students failing in geometry are due to many factors. One of the factors in geometry is the use of conventional learning. Learning geometry conventionally will hinder the progress of students' thinking and abilities because it does not take into account the difference in their level of thinking.

Therefore, teachers need to design a learning model that can meet the needs of all students, given the variation in their level of geometric thinking ability. According to Handayani, (2020) based on his research where learning with a model *project based learning* (PjBL) with a scientific approach assisted by web video can improve mathematical communication skills. According to Tasya *et al.*, (2023), efforts to increase students' interest in learning through learning models *project based learning* (PjBL) has increased. Therefore, this study will use the model *project based learning* (PjBL) by using different abilities and media.

Based on the results of an interview on May 20, 2024 with mathematics teachers, namely at SMPIT Widya Cendekia, which is the school studied, stated that the application of *the project-based learning* model is still relatively low due to the ineffective use of media. In class, only manual games are used which makes students feel bored. As an alternative to improve students' geometric thinking skills and learning interests, the use of technological media can be an effective supporter. This technology allows us to visualize material with abstract concepts and use *information and communication* (ICT)-based media that can display images to make the material easier to understand. Compared to props, this ICT media is considered more efficient and effective. Therefore, the storage of materials by teachers becomes more effective with the help of ICT media. Geogebra application is a medium that can display materials and concepts in the form of images and animations.

From the background explanation above, the problem that is overcome is the use of the Geogebra application on students' geometric thinking skills and learning interests. This can be done by developing effective learning strategies and adapting students, as well as by using the features available in the Geogebra application to support project-based learning (PjBL) learning.

METHOD

This study uses quantitative research. This class experimental research was carried out at SMPIT Widya Cendekia which is located at Jln. Empat lima, Rt. 01/023 Muntil Neighborhood, Serang, Serang District, Serang city, Prov. Banten. May 20 - June 10, 2024

The data used is *True Experimental Design the Posttest-Only Control Design,* which is by using *posttest.* By using *a posttest* , it is carried out to find out the ability of students after being given the treatment carried out after the learning process.

Tabel 1. *Posttes-Only Control Design*

X	O	experimental class

Control class	O	

Information:

O	:	*Posttest* geometry thinking ability
X	:	*Project-based learning* using the Geogebra application
-----	:	Classes are chosen randomly.

RESULTS AND DISCUSSION

A. Research Results

1. Results of Descriptive Analysis

From the research that has been conducted, data on the results of the students' geometric thinking ability test (*posttest*) in the experimental class and the control class were obtained. The data was obtained from the geometric thinking ability test instrument of students of the acronym material carried out in grades VIII B and VIII C each amounting to 17 people. The data from the research results regarding the students' geometric thinking ability test (posttest) obtained from the experimental and control classes are as follows:

2. Prerequisite Test

a. Normality Test Results

The data of the students' geometric thinking ability test (posttest) from the experimental and control classes were analyzed using the Kolmogorov-Smirnov test through SPSS software version 29. The data can be said to be normal if the sig is > a, where the value of a = 0.05. The normality test of the data of the student's geometric thinking ability test (*posttest*).

Table 2. Normality Test Results

Class	Kolomogrov Smirnov Sig.
Eksperimen	0.200*
Control	0.200*

The table above shows that the significant scores for the students' geometric thinking ability test (*posttets*) of the experimental and control classes are 0.200 each, where Sig. > 0.05. This shows that the research data is normally distributed.

b. Variance Homogeneity Test Results

The homogeneity test in this study was carried out by the Levene test using SPSS software version 29. The data are considered homogeneous if they meet the criteria of Sig. > 0.05. The results of the homogeneity test data of the students' geometric thinking ability test (*posttest*).

Table 3. Homogeneity Test Results

Class	Sig. *Based on trimmed mean*
Experiment and Control	0,822

In the table above, it is known that the significance value (Sig.) based on mean is 0.822 > 0.05. Because the significant value of the data of the student geometric thinking ability test (posttest) of the experimental and control class > 0.05, it can be concluded that the variance of the data of the student geometric thinking ability test (*posttest*) in the experimental and control classes is homogeneous.

c. Hypothesis Test Results

Hypotensis testing is used for t-tests using parametric statistics, namely independent sample *t-tests* (t-tests). The calculation process uses SPSS software version 29.

Table 4. T-test Sample Test Results

Class	*Sig.* Based on Mean
Experiment and Control Classes	0,001

Based on the table above, a sig. value of 0.001 < 0.05 was obtained, so that H0 was rejected and H1 was accepted. Because H0 was rejected and H1 was accepted, which means that the ability to think geometry (*posttest*) in the experimental class was better than in the control class. Therefore, it can be concluded that the geometric thinking ability of students who are given learning with the *Project Based Learning* (PjBL) learning model assisted by the Geogebra application is better than that given by conventional learning.

3. Results of Descriptive Analysis of Questionnaire

The questionnaire data analysis aims to find out students' learning interests during the learning process using *the Project Based Learning* (PjBL) model.

Table 5. Results of Descriptive Analysis

Class	Mean
Eksperimen	76.56
Control	59.94

In table 5, it is known that the average score of the student learning interest questionnaire for the experimental class is 76.56. Meanwhile, in the control class, the average score of the mathematics learning interest questionnaire had an average score of 59.94. Thus, after applying different treatments between the experimental and control classes, it can be seen that the experimental class that uses the *Project Based Learning* (PjBL) learning model shows better student learning interest compared to the class that uses conventional learning methods.

B. Discussion

1. Research series

This study consists of the independent variable (X), which is the Project Based Learning (PjBL) learning model using the Geogebra application, and the bound variable (Y), which is the ability to think about geometry. The material of the study is the material used in this study.

Steps in the application of the learning model *Project Based Learning* (PjBL) by the researcher includes: Step (1) Determining the Fundamental Questions; Step (2) Designing Project Planning; Step (3) Prepare a Schedule; Step (4) Monitor students and project progress; Step (5) Testing the results; Step (6) Evaluate the experience (Kusuma *et al*., 2021). In the use of learning models *Project Based Learning* (PjBL) using the Geogebra application, students are required to practice geometric thinking skills because students will look for the necessary data so that they can grow interest in learning. Students will make better use of other relevant sources in solving their problems. Student learning objectives are more measurable because there are math projects that must be completed. The project given to students will be presented as material for evaluating the student learning process and outcomes.

2. Students' Geometric Thinking Ability between Project Based Learning Learning Models with Geogebra Applications and those Using Conventional Models.

Based on data analysis, it was concluded that there was a difference in geometric thinking ability between students in the experimental class and the control class. The experimental class showed a higher average score than the control class. Therefore, *the Project Based Learning* (PjBL) learning model that uses the Geogebra application has proven to be more effective in improving students' geometric thinking skills compared to conventional learning models.

From the learning process in the experimental class, data was obtained which was then analyzed by researchers. From the results of the geometric thinking ability test, it can be seen that students have been able to solve the given problems, solve problems by involving models and answer problems using words or written text. This can be seen in attachment 8 of the posttest results *of the* geometric thinking ability test of experimental class students. From the results of each item of the geometric thinking ability test, the students of the experimental class have reached a maximum score of 5 which means that the answers to the test results of the students have met the five indicators of geometric thinking ability that have been determined by the researcher. Here is an example of the answer result from one of the students in the experimental class:

a. Level 0 (Introduction)

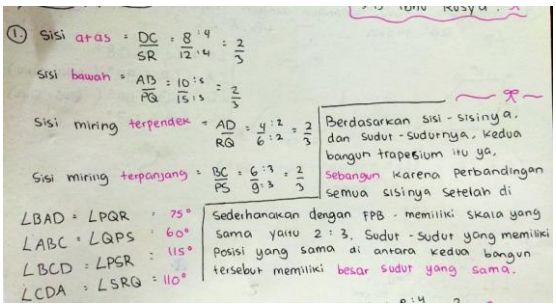

Figure 1. Student Answer Results

Number 1 Level 0 (Introduction)

Figure 1 Showing the results of the work of high-category students who are able to answer perfectly, number 1 can name the corresponding sides and the corners that are located are of equal value and include the appropriate reason. With PBL, students are involved in projects that require the practical application of geometry concepts. The GeoGebra app, which allows students to visualize and explore various geometric concepts interactively, supports a deeper understanding through hands-on experience. According to PjBL it often involves group work, which encourages students to discuss and explain their ideas to others (General *et al*., 2020). With GeoGebra, students can share their geometric models and discuss various solutions or approaches, which helps them in understanding and internalizing concepts (Kramarenko *et al.*, 2020).

b. Level 1 (Analysis)

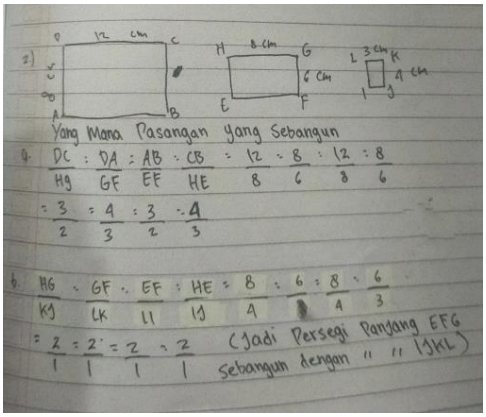

Figure 2. Student Answer Results
Number 2 Level 1 (Analysis)

Figure 2 shows the analysis level answers by high-category students, i.e. students easily find the appropriate sides of the picture and include the appropriate reasons. By working on a real-world-based project that utilizes GeoGebra, students must analyze the situation and determine how mathematical concepts can be applied to solve the problem (Septian et al., 2020; Yohannes & Chen, 2023). After identifying the faults, students can reflect on their solutions and correct them, which helps in honing their analytical and problem-solving skills. This means that the use of GeoGebra in the context of Project Based Learning enriches the learning experience of students by providing tools that allow them to analyze and understand mathematical concepts in depth.

c. Level 2 (Informal Deduction)

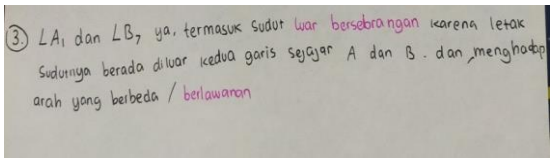

Figure 3. Student Answer Results
Number 3 Level 2 (Informal Deduction)

Figure 3 perfectly shows the informal deduction level answers of high-category students who are able to answer informal deduction level questions by drawing conclusions, but there are still answers that are lacking because the explanation is not complete. Nevertheless, students have a deep understanding of mathematical concepts. Royek in PjBL often involves complex and open issues. GeoGebra provides tools for students to build and explore solutions visually, allowing them to perform in-depth analysis and deduction of how various elements interact with each other and affect outcomes (Septian *et al*., 2020).

d. Level 3 (Deduction)

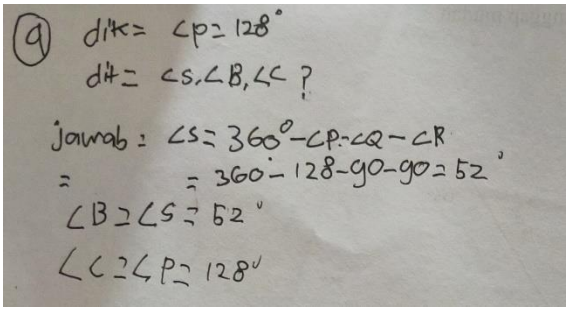

Figure 4. Student Answer Results

Number 4 Level 3 (Deduction)

Figure 4 shows the answers of the deduction level by high-category students who are able to answer all deduction level questions easily, find what the picture on the question knows and answer correctly. With GeoGebra, students can explore different approaches to solve problems and perform deductions to assess the strengths and weaknesses of each approach. It helps in developing students' critical and deductive thinking skills (Vahlepi *et al.*, 2021).

e. Level 4 (Accuracy)

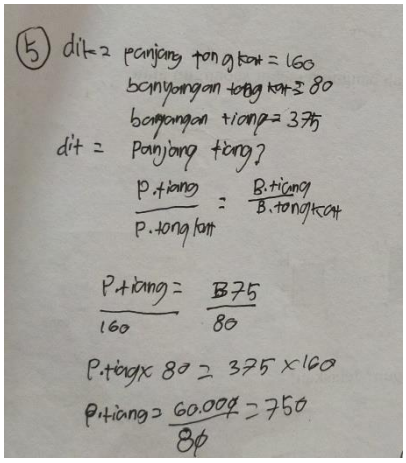

Figure 5. Student Answer Results

Number 5 Level 4 (Accuracy)

Figure 5 shows the accuracy level answers by high-category students who are able to answer all accuracy level questions easily find what the pictures on the questions know and answer correctly.

Based on the results of the answers of the students of the experimental class above, it shows that answers number 1 to 5 are included in the high category. It's just that the answer in question number 3 still has a missing answer because the explanation is not complete. While the answers to question numbers 1, 2, 4 and 5, all the answers to the questions are included in the accuracy level. Students easily find what the pictures on the questions know and answer appropriately. GeoGebra as a tool in the Project Based Learning model provides an effective way to improve students' accuracy skills. By enabling visual exploration, precision measurements, and in-depth

data analysis, GeoGebra supports students in producing precise and accurate results in their math projects (Kramarenko *et al*., 2020; John & Chen, 2023).

3. Students' Learning Interests between Project Based Learning Models with Geogebra Applications and Those Using Conventional Classrooms

Based on the analysis of research data, the model *Project Based Learning* (PjBL) assisted by the Geogebra application has proven to be effective in improving students' geometric thinking skills and learning interests. This shows that there is a difference in learning interest between students who follow the PjBL model and the Geogebra application and students who follow the conventional learning model. The results of previous studies also support these findings, by showing that students' interest and learning outcomes in the experimental class were higher compared to the control class (I. Hamidah & Citra, 2021).

In learning that uses models *Project Based Learning* With the help of the Geogebra application, students show a higher enthusiasm for learning mathematics, become more active in classroom activities, and successfully solve complex problems. In addition, this model encourages students to develop as well as practice their communication skills and improve collaboration between students. In line with this, according to (Wayan Sunita *et al*., 2019) With the mathematics project given, students become more interested in discussing and working on the project because the mathematical concepts used in the project are very relevant to their daily lives. This project provides opportunities for students to learn and develop according to real-world situations.

With the application of *the Project Based Learning* (PjBL) learning model assisted by the Geogebra application, learning in the classroom becomes more interesting. This makes students more enthusiastic about learning, including those who are initially less interested in mathematics. The project assignments given encourage students' creativity and enthusiasm for learning, so that their interest in learning increases. The results of the student response questionnaire also showed that there was a difference in learning interest between students who used the *Project Based Learning* (PjBL) model and the Geogebra application compared to other learning methods.

CONCLUSION

The geometric thinking ability and interest in learning mathematics of students who are given learning with *the project-based learning* model assisted by the Geogebra application are better than those given by conventional learning. The use of GeoGebra in the PjBL model can provide a more interesting and effective learning experience in improving students' geometric thinking skills and interest in learning mathematics. This approach leverages the power of interactive visualization and practical application, which can make math more relevant and enjoyable for students.

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