



Experimentation of Think Pair Share learning assisted by GeoGebra software on students' mathematics learning outcomes

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Abstract: This study seeks to identify learning models that influence students' mathematics learning outcomes. Based on the level of absorption, the learning outcomes of the SMK Terpadu Jannatul Firdaus students have not yet reached the KKM and the learning outcomes in mathematics are not good or low, especially in the field of quadratic function equations, due to the not optimal indicators of the learning process at the school. One solution that can be applied is the Think Pair Share (TPS) learning model assisted by GeoGebra Software. This quantitative experimental research used a quasi-experimental design, namely the Posttest Only Control Design with a population of all students of class XI at SMK Terpadu Jannatul Firdaus. The sampling technique used cluster random sampling with three randomly selected samples, two as the experimental class and one as the control class. The first experimental class was taught through the application of the TPS learning model assisted by GeoGebra Software, the second experiment used the TPS learning model only, and the third was used as a control class using the conventional model. The research instrument uses a mathematics learning achievement test instrument. The research hypothesis uses Anova test and post-Anova test. The results showed that students who were taught using the TPS model assisted by the GeoGebra Software obtained a better average and outperformed compared to students who were taught using the conventional model or only the TPS model, as calculated in this study, F_{count} was 8.620, which was greater than F_{table} , which was 3.096.

Keywords: GeoGebra software; Learning outcomes; Think Pair Share

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INTRODUCTION

Education is one vehicle for student development. Through education, students can develop knowledge, knowledge and skills. In addition, with education students will learn to think to solve problems, make decisions and seek understanding of something (Rahmawati, 2021). The science of structures, patterns and representations of things that have developed and taken root in the real world is known as mathematics. The same shapes, structures and patterns can be found in mathematics in everyday life.

One of the goals in learning mathematics is for students to have the ability to learn from students in understanding mathematical concepts, explaining the interrelationships between concepts and applying concepts or algorithms, in a flexible, accurate, efficient, and precise manner, in solving problems (Konita et al., 2019). There are many students who, after learning mathematics, are unable to understand even the simplest parts, many concepts are misunderstood so that mathematics is considered a difficult, complicated, and difficult science



(Aledya, 2019). This can be seen in the facts in the field stating that some students solve problems by going straight to the answers without explaining how the process of solving them is. This was proven when the final semester exam work revealed that the results achieved were not as expected. Low student learning outcomes are a result of the general tendency of students to understand problems less well. SMK Terpadu Jannatul Firdaus class XI consists of two majors, namely OTKP (Office Management Automation) and TKJ (Computer Network Engineering) with each department consisting of two classes and a total of 118 students. Only 38.9% of students achieved KKM, so that the average score of student learning outcomes at school was below the Minimum Completeness Criteria (KKM), namely 70. Overall student learning outcomes also fell. Material on equations and quadratic functions is what triggers the low achievement of students in mathematics.

A very significant and closely related subject in life is mathematics. In order for students to be motivated to learn it and that their academic performance is optimal, mathematics must be taught in an engaging way that is connected to the real world. Based on the information and observations obtained from the mathematics teacher at the SMK Terpadu Jannatul Firdaus, especially in relation to the educational process that takes place in the classroom, more specifically in the use of learning models, namely still applying conventional learning models or using the lecture method. The monotonous nature of the presentation of material and learning which is still teacher-centered can be reduced so that students do not tend to ignore the teacher's explanations. This is one of the reasons students find it difficult to understand mathematics which results in a decrease in their learning outcomes. Faizah (2020) also explained that the conventional model is explaining material, providing examples and practice questions so that students are trained to work on questions like a machine.

Class observations revealed that some students still had difficulty applying their knowledge of quadratic equations and functions in problem solving. Students still do not know how to solve the questions given. There is no way for students to find solutions to problems if they are only imitating and guided by the teacher. As a result, students often learn by memorizing rather than understanding the material. Therefore, it is hoped that the Think Pair Share (TPS) learning model supported by GeoGebra Software can answer these problems. Relevant research conducted by (Handayani & Yanti, 2017) in class VIII mathematics learning at SMP Negeri 1 Binjai states that increased student learning outcomes affect the mathematical problem solving abilities of students who learn through the Think Pair Share (TPS) cooperative learning model assisted by GeoGebra higher than students who learn through direct learning models at SMP Negeri 1 Binjai.

The Cooperative Learning Model, namely Think Pair Share, is a group learning model that not only trains students to think individually but also trains students to work together also with the help of learning media, namely GeoGebra software, which can encourage the process of discovery and experimentation of students in class. Its visualization features can effectively assist students in presenting material with a clear purpose so that it can make students understand better when studying and can improve their learning outcomes. Another benefit of combining the GeoGebra-assisted TPS model is that it can create a fun learning atmosphere and the goals of the learning process can be maximized. Because the purpose of the learning process can occur if there is interaction (cooperation) between the individual and his friends and the environment. This interaction can be created through the use of appropriate learning resources and media.

TPS learning has three stages, namely thinking, pairing and sharing (Parianti, 2016). The TPS model is a group-based model. The concept of the TPS model is that it can encourage students to work both individually and in pairs to solve problems given by the teacher (Kartini, 2019). Meanwhile, according to (Asrika et al., 2020) TPS learning begins with the teacher asking questions or subject matter for students to think about individually. Next, the teacher asks students to pair up with their desk mates to discuss, then the results of the discussion between

the pairs are presented in front of the class to be shared with other groups. The teacher acts as a facilitator.

This learning model teaches students to think critically on their own, trains students to think and discuss by expressing opinions with their peers, and instills students' self-confidence when presenting answers (Meinalufi et al., 2021). So, it can be concluded that with the application of the TPS learning model, which means that student participation in the learning process can reduce boredom compared to just listening to the teacher explain. Students can also help each other in critical thinking or become peer guides so that students understand and understand material that can have an impact on learning outcomes that have increased. However, if the TPS learning stage is carried out directly by giving question sheets, there is a problem with the implementation of the TPS model which makes TPS unable to be implemented better, and the learning is not ideal and less than optimal.

Using the classical learning method in the teaching and learning process is the answer to this problem. The problem of using the TPS model can then be reduced by using the GeoGebra program with learning media or tools, because the GeoGebra software can describe and show how mathematical concepts are constructed. Media is a tool that has the function of conveying messages (Agung, 2018). GeoGebra is very useful as: 1) demonstration and visualization media; 2) construction aids; 3) discovery process aids; and 4) communication and representation tools (Ifanda et al., 2017). Choosing the right learning media can support the achievement of learning objectives and create a more active and interactive learning atmosphere (Abrar, 2018).

Knowing this, by incorporating the GeoGebra software-assisted learning model can be used as a mathematics learning medium to make it easier for students to understand the material. With the GeoGebra program, abstract mathematical objects can be visualized and manipulated quickly and efficiently (Fitriasari, 2017). GeoGebra software is a math learning tool or media that can be installed either on cell phones, laptops, or computers as an IT-based program to make it easier for students to understand the material (Dwiningrum, 2021). By using GeoGebra software when learning, students can actively participate in understanding, solving problems, conceptualizing, and improving their skills in the content offered in an interesting and fun way (Rasyid et al., 2022). Students can optimize their learning outcomes in mathematics as a direct result of their increased enthusiasm for the subject.

Experimentation of the TPS learning model assisted by GeoGebra software is a form of learning that begins with the Syntax of the Think Pair Share (TPS) learning model, which begins with the teacher asking questions related to the material to be delivered, the teacher provides opportunities for students to think about answers to the questions given, then the teacher asks students to discuss with their peers. In this stage students convey solutions to each other's questions with the help of the GeoGebra application to find common ground for issues that have been resolved individually, the results of this discussion are then conveyed to their classmates, namely at the sharing stage. So, it is hoped that with the Think Pair Share (TPS) learning model assisted by GeoGebra Software it can streamline students' mathematics learning after attending lessons the learning outcomes increase and students who feel bored, bored, and think that mathematics is very difficult can be minimized. Especially in the matter of quadratic equations and functions that study numbers, square roots and graphs. It is in this context that the researcher conducted an experimental study of the TPS learning model assisted by the GeoGebra software in the process of obtaining achievement in learning mathematics.

METHOD

This quantitative experimental research uses a quasi-experimental design, namely the Posttest Only Control Design, which describes the methodology used here. Specifically, this study used an experimental design in which participants were divided between an experimental group as well as a control group. Table 1 explains that X_1 is treated with the TPS learning model assisted by GeoGebra Software, X_2 is treated with the TPS learning model, and X_3 is treated

with conventional learning models. Then, O_1 is compared to O_2 and compared to O_3 as a final test. Population according to (Sugiyono, 2017) population is an area of generalization that occurs from objects or subjects that have certain qualities and characteristics determined by researchers to be studied. The population used by researchers in this study were all class XI students of the SMK Terpadu Jannatul Firdaus for the 2022/2023 academic year, totaling 118 students.

Table 1. Research Design

Group	Treatment	Posttest
Experiment 1	X_1	O_1
Experiment 2	X_2	O_2
Control	X_3	O_3

Researchers used the cluster random sampling method when collecting samples for their research. The sampling technique was chosen randomly without regard to strata because it consisted of 4 classes of which 3 classes would be taken as samples. According to Hidayat (2012) explains that Cluster Random Sampling is a random sampling that is not individual, but small groups of units. The sample was then selected through a random process, Class XI OTKP A became the first experimental class, Class XI TKJ A became the second experimental class, and Class XI OTKP B became the control class thereafter. The first experimental class was taught through the application of the TPS learning model assisted by GeoGebra Software, the second experiment used the TPS learning model only, and the third was used as a control class using the conventional model.

In this experiment, the initial data used were the odd semester exam scores at the SMK Terpadu Jannatul Firdaus and the final data were the test scores at the time of the study. Researchers used the test method to evaluate how well students understand the material on quadratic equations and functions. In this investigation, the researcher uses a testing strategy known as the Posttest method. The definition of posttest is one of the most widely used measuring tools to determine the success of an educational program (Pudyastuti, 2017). This test instrument is in the form of an objective test and consists of five indicators. The indicators are given in the form of multiple-choice questions with five different answer choices. On the posttest there are a total of fifteen questions to answer. One-way Anova test and post-anova test were used in the analysis of data collected from student learning tests on quadratic equations and functions. The Anova test aims to explain the difference in treatment, namely between using the TPS model assisted by GeoGebra Software, the TPS learning model only and the conventional model on student learning outcomes. While the post-anova test aims to explain which learning model has a better effect in learning taught or applied to the TPS model assisted by GeoGebra Software, the TPS learning model only and the conventional model.

Before it can be used with the Anova test, there are prerequisites that must be met for data analysis to be carried out. In this special investigation, the normality test uses the Liliefors test, the balance test uses the same one-way Anova test, and the homogeneity test uses the Bartlett test which functions as a prerequisite assessment. Data analysis based on the hypothesis can be carried out after it is known that the data follows a normal distribution, the students' initial abilities are the same or balanced, and the data is homogeneous.

RESULTS

This research investigates whether students can achieve comparable math results by using the TPS learning model assisted by GeoGebra Software, the TPS only model, or the conventional learning model. The research was conducted using an experimental design. According to the findings, the TPS learning model assisted by GeoGebra Software is the most successful of the three approaches.

The research test instrument referred to was initially tested on the class of respondents or also known as the class that was not included in the sample. The respondent class used was class XI with a total of 30 students. This study uses instruments that have previously been validated through an instrument testing process. After it has been established through a balance test that the starting point for each group is the same, the population is normally distributed, and the data is homogeneous, the hypothesis testing can be continued with a one-way cell analysis of variance test. The hypothesis test aims to determine whether the use of various learning models affects students' mathematics learning outcomes.

The results of the preliminary test of students' initial ability data in the three classes were obtained from the math scores of the Odd Semester Final Examination for the 2022/2023 academic year which were tested first with normality, homogeneity, and balance tests. The normality test of students' initial ability data is used to determine whether the sample is normally distributed or not. The normality test in this study used the liliefors method. The initial normality test in the experimental group 1 obtained $L_{obs} = 0.095$, in the experimental group 2 obtained $L_{obs} = 0.114$, and in the control group obtained $L_{obs} = 0.146$, with $L_{table} = 0.161$. $DK = (L_{max} | L_{max} \geq L_{an})$ because $L_{count} < L_{table}$, then H_0 is accepted. Thus, the three samples in the initial normality test came from populations with normal distribution. The next test with the homogeneity test is used to find out whether the samples have the same variance or not. The homogeneity test for this research data uses the Barlett test with a significance level of 5%. The results of the homogeneity test of the initial ability data on student learning outcomes, namely $X^2_{count} = 0.03 < X^2_{table} = 3.84$, obtained that the three classes of learning models have the same variance (homogeneous). Furthermore, for the balance test in this study using the Anova test or the same way, so that before the data is tested, prerequisite tests must be carried out, namely the normality and homogeneity tests first.

Table 2. Initial Ability Balance Test

Source	JK	dk	RK	F_{count}	F_{table}	P
Class	132,8	2	66,40	0,4507	3,0966	$F_{count} < F_{table}$
Error	13405	91	147,31			
Total	13538	93				

Based on **Table 2** The results of the balance test using the one-way Anova test are the same with a significance level of 5%, it can be concluded that $F_{count} = 0.4507 < F_{table} = 3.0966$, which means that the three classes are in a balanced state.

The next stage is to test the research prerequisites, using the posttest data on student learning outcomes taught using the TPS-Software GeoGebra learning model, TPS, and conventional learning. The results of the final normality test (posttest) in the experimental group 1 obtained $L_{obs} = 0.094$, in the experimental group 2 obtained $L_{obs} = 0.106$, and in the control group obtained $L_{obs} = 0.119$, with $L_{table} = 0.161$. $DK = (L_{max} | L_{max} \geq L_{an})$ because $L_{count} < L_{table}$ indicates that H_0 is accepted, which means that the data on student learning outcomes from all classes and groups are normally distributed. And the final homogeneity test (posttest), namely $X^2_{count} = 1.35 < X^2_{table} = 3.84$ with this it can be concluded that H_0 is accepted, or the sample comes from a population that has the same variation.

After carrying out the prerequisite test as a condition in analyzing the Anova hypothesis test with student learning outcomes data stated to be balanced, normally distributed, and homogeneous, then the first hypothesis with Anova is the same cell path.

Table 3. Results of Analysis of Variation (Anova) One Same Cell Way

Source	JK	Dk	RK	F_{count}	F_{table}	P
Class	2776,34	2	1388,17	8,6208	3,0966	$F_{count} > F_{table}$
Error	14653,2	91	161,02			
Total	17429,6	93				

Analysis of students' progress in understanding equations and quadratic functions shows that at a significance level $\alpha = 0.05$ H_0 is rejected, with $F_{\text{count}} = 5.1114 > F_{\text{table}} = 3.090$. Based on the data obtained $F_{\text{count}} = 5.1114 > F_{\text{table}} = 3.090$ which shows that students' knowledge has increased. Thus, it can be concluded that the average student learning outcomes in the three groups, both the experimental group and the control group, have a different effect on the mathematics learning outcomes of class XI students of the SMK Terpadu Jannatul Firdaus.

Based on the results of a one-way Anova obtained from the same sample, then it is continued or continued with a multiple comparison test, also known as a follow-up test, can be carried out with the Scheffe method. The Scheffe method is used to compare the relative effectiveness of the three learning models in relation to student achievement outcomes. Table 4 summarizes the results of several comparison tests that were run.

Table 4. Post Anova Test Results

H_0	RKG	F_{count}	$2 F_{\text{table}}$	Test Decision
$\mu_1 = \mu_2$	161,02	2,25	6,18	H_0 accepted
$\mu_2 = \mu_3$	161,02	6,77	6,18	H_0 rejected
$\mu_1 = \mu_3$	161,02	16,85	6,18	H_0 rejected

$F_{1-2} = 2.25$, $F_{2-3} = 6.77$, and $F_{1-3} = 16.85$ are the results of the multiple comparison test, and $D_k = \{F|F > (2) (3.09)\} = \{F |F > 6.18\}$. There is a significant difference between F_{count} and critical area, so that the following conclusions can be drawn: First, at $H_0: \mu_1 = \mu_2$ is accepted, indicating that the TPS learning model assisted by GeoGebra Software has the same effect on student learning outcomes regardless of treatment. The second hypothesis, $H_0: \mu_2 = \mu_3$ is rejected, which shows that the TPS learning model is different from the conventional model in terms of its effect on students. When comparing the class average scores, Table 4 shows that the TPS learning model is better than the conventional learning model. This conclusion can be drawn because of the superiority of the TPS learning model. Third, at $H_0: \mu_1 = \mu_3$ is rejected, indicating that the TPS learning model assisted by GeoGebra provides different results for students compared to the conventional model. This is because the GeoGebra Software is integrated into the TPS learning model. By comparing the GeoGebra Software-assisted TPS learning model class with conventional learning model classes in Table 4 it shows that the GeoGebra Software-assisted TPS learning model class has a higher average value. In particular, from the fact that the TPS learning model supported by GeoGebra Software has more influence on student learning outcomes.

Based on the summary of the results of the one-way analysis of variance, it was concluded that $F_{\text{count}} > F_{\text{table}}$ with a value of $F_{\alpha} = 8.620$ and a value of $F_{\text{table}} = 3.090$ so that from these tests there were differences in the influence of the TPS learning model assisted by GeoGebra Software, the TPS learning model, and the conventional learning model. This is in accordance with the results of research (Maryani, 2017), entitled The Effect of the GeoGebra Assisted Think Pair Share Model on Students' Mathematical Reasoning Ability. After participating in the Think Pair Share learning facilitated by GeoGebra, students' mathematical reasoning abilities increased as shown by the results of the analysis of variance (ANOVA) test with $F_{\text{count}} > F_{\text{table}}$, which means H_0 is rejected and H_1 is accepted. Based on Table 4, the summary of comparisons and learning model hypotheses shows that the TPS learning model assisted by GeoGebra Software has better learning outcomes than students who apply the TPS learning model and conventional learning models. The following is data from the start, both before and after the implementation of the learning model.

DISCUSSION

From Table 5 Obtained for the initial data, namely class XI OTKP A obtained an average of 62.9, class XI TKJ A with an average of 60.0, and class XI OTKP B obtained an average of 61.2. Meanwhile, the final data for class XI OTKP A obtained an average of 75.3, class XI TKJ A with

an average of 70.5, and class XI OTKP B obtained an average of 62.1. So that it can be concluded that class XI OTKP A both in the initial data and the final data get a greater average than the other classes. High learning outcomes due to the effect of an effective learning model.

Table 5. Student Learning Outcomes

Treatment	Group	Class	The number of students	Value maks	Value min	Average
Before	Experiment 1	XI OTKP A XI	31	85	40	62,9
	Experiment 2	TKJ A	31	83	40	60,0
	Control	XI OTKP B	31	83	40	61,2
After	Experiment 1	XI OTKP A XI	31	90	50	75,3
	Experiment 2	TKJ A	31	90	40	70,5
	Control	XI OTKP B	31	80	40	62,1

Previous research conducted by Noviana et al. (2020) also stated that the GeoGebra-assisted TPS learning model is better than the conventional learning model. In GeoGebra-assisted TPS learning, the role of student activity and learning media in the student learning process is very influential on learning outcomes. So, with that in mind, this study conducted experiments by comparing the TPS learning model assisted by GeoGebra software, the TPS learning model, and with conventional models. And it was concluded that this study also got better and improved student learning outcomes, namely by implementing the TPS learning model assisted by GeoGebra software due to the use of effective assessment with feedback from friends to help students understand the material, especially in the matter of quadratic equations and functions. Students' difficulties in understanding, analyzing, and solving problems in the matter of quadratic equations and functions can be overcome with the help of GeoGebra media, especially in applications or media that can determine the roots of quadratic equations and can be used in drawing graphs on quadratic functions.

In addition, media or GeoGebra software tools that can visualize mathematical concepts in the material of quadratic equations and functions and can draw and determine equations as well as coordinates directly so that students more quickly understand the location of errors in solving them manually without the GeoGebra software mathematics learning media.

CONCLUSION

Based on the first hypothesis in this study using the One Way Anova Test which states that there are differences in the effect of the TPS learning model assisted by GeoGebra software, the TPS learning model, and conventional learning models on student mathematics learning outcomes. From the same one-way anova calculation, the value of $F_{count} > F_{table}$ is obtained so that H_0 is rejected. This means that there are significant differences between students who are given the TPS learning model assisted by GeoGebra software, the TPS learning model, and the conventional learning model. The second hypothesis shows that $F_{count} < F_{table}$, which means that learning TPS assisted by GeoGebra software and TPS have the same effect on learning outcomes. The third hypothesis of the calculation shows $F_{count} > F_{table}$, which means that TPS and conventional learning have different effects on student learning outcomes. The TPS learning model provides better mathematics learning outcomes than conventional learning models. The fourth hypothesis shows that $F_{count} > F_{table}$, which means that learning TPS assisted by GeoGebra, and conventional software has different effects. The TPS learning model assisted by GeoGebra software provides better mathematics learning outcomes than conventional learning models.

In addition, from this study which states that there are significant differences in the experimental class and the control class can be taken into consideration by the teacher in carrying out learning. Researchers also recommend that further studies be carried out to expand and build on what researchers have done at the same level, content, or different

variables or use different learning models to develop understanding, knowledge, and overall quality in education can gain improvement, especially by mastery of the features provided by GeoGebra with the aim of being able to display more dynamic examples and illustrations, and develop material on other material in the field of mathematics.

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