International Journal of Scientific Multidisciplinary Research (IJSMR)
Vol.2, No.7, 2024: 875-888

Comparison of the Effectiveness of Cooperative Learning Models TPS and GI on Students' Mathematical Concept Understanding Ability

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A R T I C L E I N F O
Keywords: Comparason, Think Pair Share, Group Investigation, Concept Understanding, Mathematics

Received : 2 May
Revised : 10 June
Accepted: 17 July

A B S T R A C T
This study aims to determine whether the TPS or GI learning models are more effective for students' understanding of mathematical concepts. Conducted at Dr. Wahidin Mlati Junior High School during the academic year 2023/2024, the research utilized a quasi-experimental design with a non-equivalent posttest only control group and simple random sampling technique. In experimental class 1, a significance value of 0.202 > 0.05 was obtained for normality test, and in experimental class 2, a significance value of 0.155 > 0.05 was obtained, indicating normal distribution of both classes' posttest scores. The homogeneity test of posttests yielded a significance value of 0.09 > 0.05, indicating homogeneity of variance between the two classes. Regarding the hypotheses testing, the first hypothesis showed $t_{count} > t_{table}$ with 11.68 > 1.69, indicating that the TPS learning model effectively helps students understand mathematical concepts. The second hypothesis showed $t_{count} > t_{table}$ with 4.92 > 1.69, indicating that the GI learning model effectively influences students' ability to understand mathematical concepts. The third hypothesis showed $t_{count} > t_{table}$with 2.87 > 1.99, indicating that the TPS learning model is more effective than the GI learning model for understanding mathematical concepts among seventh grade students at Dr. Wahidin Mlati Junior High School

DOI: https://doi.org/10.55927/ijsmr.v2i7.10034
ISSN-E: 2986-5042
https://journal.formosapublisher.org/index.php/ijsmr

INTRODUCTION

Education is the most important aspect in human life to ensure the protection of the nation and the state (Williamson, 2024). Education is also necessary to enlighten the nation's children for the advancement of the nation and the state. For the nation and the state to develop, quality educational support is essential (Olena et al., 2022). However, in Indonesia, there are still several obstacles related to improving the quality of education.

The educational process in schools is expected to align with national educational goals (Avelar et al., 2023; Putri & Siswanto, 2024). However, in reality, achieving national educational goals is not easy due to several factors influencing the low quality of education. According to Hordvik & Beni (2024) and Rahim et al. (2022), teachers play a pivotal role in classroom learning, serving as the mainstay of the school learning process. Active participation and interaction between students and teachers in the classroom are crucial aspects in creating a learning process (Siswanto et al., 2024). Their participation significantly impacts achieving learning objectives. Furthermore, Pisriwati et al. (2024) states that student involvement in the learning process will manifest the necessary skills that students must possess, thereby enhancing their learning achievements. This certainly encompasses various fields of learning such as mathematics (Siswanto et al., 2024).

Mathematics is one of the crucial subjects because it teaches not only numerical calculations but also critical and logical thinking in problem-solving (Wakhata et al., 2023). Moreover, Solihah et al. (2024) suggests that mathematics plays a significant role in developing analytical skills, the ability to convey information, and problem-solving skills that can be communicated orally, in writing, schematically, or graphically.

A key objective of mathematics learning is conceptual understanding (Siswanto & Peni, 2023; Villarin et al., 2024). Students not only learn and memorize mathematical formulas and knowledge but also gain deeper understanding by comprehending the materials and concepts (Santosa et al., 2022). Furthermore, Elind et al. (2022) indicate that conceptual understanding also helps students develop mathematical thinking. Students must grasp concepts based on these explanations, which are essential for problem-solving.

Based on initial interviews with mathematics teachers at Dr. Wahidin Mlati Junior High School, it is evident that a common issue in learning is that students tend to memorize concepts rather than understand them. Students are not extensively involved in investigative activities, problem-solving, as well as analyzing and evaluating problems. Only a few students actively participate in classroom learning due to the lack of student engagement in the learning process.

Based on observations of test scores for algebra in Grade VII, even semester, at Dr. Wahidin Mlati Junior High School, the results can be seen in Table 1 below.

Table 1. Test Scores for Each Concept Understanding Indicator

	Indicator						
Description	A	B	C	D	E	F	G
Average	60	77	66	63	66	70	68

Based on the table above, it can be seen that: (1) A "Restating concepts" averages 60; (2) B "Classifying objects based on specific properties according to concepts" averages 77; (3) C "Providing examples or non-examples of a concept" averages 66; (4) D "Presenting concepts in various mathematical representations" averages 65; (5) E "Developing sufficient and necessary conditions of a concept" averages 66; (6) F "Using and selecting specific operations" averages 70; (7) G "Applying concepts to problem-solving" averages 68.

The test questions are in the form of essays containing concept understanding indicators. From the completeness of the test scores, it can be seen that the majority of students have not met the minimum criteria set by the school, which is 75. Therefore, it can be concluded that the understanding of mathematical concepts among seventh-grade students at Dr. Wahidin Mlati Junior High School is still low. One way to improve understanding of concepts is through cooperative learning (Nanor et al., 2024; Alghiffari et al, 2024).

Cooperative learning guides students to actively participate in solving problems together in groups (Ramdani et al., 2022; Mahanal et al., 2022; Siswanto et al., 2024). There are various cooperative learning models in education, such as the Think Pair Share (TPS) type. The TPS learning model has several advantages, such as easy group division and enhanced discussion among students (Hasan & Yalçin, 2018). According to Tabassum & Sadiq (2024), the TPS learning model involves paired discussion followed by whole-group discussion, which fosters collaborative thinking to understand a problem and identify its causes, effects, and solutions. The discussion method used in the TPS learning model divides participants into several groups, each consisting of two people, allowing more time to share within the group (Engelbertink et al., 2020). Based on the explanation above, the TPS learning model through discussion can facilitate students' understanding of the taught concepts.

In addition to TPS, the Group Investigation (GI) learning model is another cooperative learning model that can be implemented in junior high school students (Febrina & Dores, 2022). According to Slavin (2005), there are several stages in the GI learning model, such as investigation, where students can enhance their ability to develop strategies and tactics, including defining problems to be solved and writing answers to problem-solving questions. Moreover, in investigation, students can improve their ability to explain, including analytical and synthetic functions. Students can enhance their ability to reason and solve problems, as well as identify additional options to solve these problems in the presentation and evaluation stages. Based on the description above, this model requires students' abilities to understand concepts.

Adha et al. (2024) and Siagian et al. (2023) stated that the GI collaborative learning model is considered less effective compared to TPS in enhancing students' mathematical critical thinking skills. Based on the description above, researchers are interested in conducting a study entitled comparison of TPS and GI learning models on students' understanding of mathematical concepts.

METHODOLOGY

The type of research used is quasi-experimental with a non-equivalent posttest only control group design. This research was conducted in February 2024 at Dr. Wahidin Mlati Junior High School, located at Jl. Magelang km 5, Sinduadi, Mlati, Sleman, D.I.Y, in the academic year 2023/2024, involving classes VII A, VII B, VII C, and VII D as the population. Sampling was done using simple random sampling, where class VII C was selected as experimental group 1 treated with the TPS model and class VII D as experimental group 2 treated with the GI model. Information collected from this research includes observation sheets of educational implementation and the results of concept description skill tests. According to Arikunto (2014), the observed data is analyzed using percentage calculations.

The results of the concept understanding test use hypothesis testing 1 to identify whether education using the TPS model is effective if the criteria are met with an average student score in experimental group 1 categorized as good (≥ 75). Hypothesis testing 2 is used to identify whether education using the GI model is effective if the criteria are met with an average student score in experimental group 2 categorized as good (≥ 75). Hypothesis testing 3 aims to determine whether there is a difference in the average concept understanding abilities of seventh-grade students at Dr. Wahidin Mlati Junior High School on triangle material between those using the cooperative learning model TPS or GI.

RESULTS

The study was conducted in class VII C as experimental group 1 using the TPS cooperative learning model and class VII D as experimental group 2 using the GI cooperative learning model. The research implementation followed the research schedule as presented below. During the study, the researcher was accompanied by three observers to observe and provide feedback on the ongoing learning process.

The implementation of the lessons was adjusted according to the lesson plans prepared by the researcher for both experimental groups using student worksheets. From February 9-18, 2024, the researcher conducted a pilot study in class VIII C and obtained the results of validity and reliability tests, difficulty level, and item discrimination of the post-test instrument related to students' understanding of mathematical concepts, detailed as follows.

Table 2. Summary of Trial Results

No. of item	Validity ($r_{table} = 0,349$)		Reliability (Cronbach's Alpha)		Difficulty index		Differentiating Power	
	r_{count}	Criteria	Value	Criteria	Value	Criteria	Value	Criteria
1	0,627	Valid	0,746	Reliable	0,681	Enough	0,323	Enough
2	0,673	Valid			0,632	Enough	0,333	Enough
3	0,574	Valid			0,683	Enough	0,311	Enough
4	0,559	Valid			0,637	Enough	0,333	Enough
5	0,424	Valid			0,632	Enough	0,288	Enough
6	0,472	Valid			0,676	Enough	0,333	Enough

Based on the table, all item numbers in the questions are valid and reliable. The reliability result obtained a value of 0.746 > 0.005, indicating that all items meet the reliability criteria. All items scored at a moderate difficulty level and had sufficient item discrimination. Based on the results of the post-test pilot study, it can be stated that the post-test instrument is suitable for use in the research.

Following the completion of the study, observational data was obtained from experimental group 1 using the TPS model and also from experimental group 2 using the GI model. The observations from three observers were averaged. The observation results for experimental group 1 can be seen in the following table.

Table 3. Implementation Results for Experiment 1 Class Teachers

	Percentage			**Criteria**
	Meeting I	**Meeting II**	**Average**	
Teacher	100	94,12	97,06	Very Good

Table 4. Experimental Class 1 Student Implementation Results

	Percentage					**Criteria**
	Meeting 1		**Meeting 2**		**Average**	
	Observer 1	**Observer 2**	**Observer 1**	**Observer 2**		
Student	89,3	95,72	95,72	96,79	94,38	Very Good

Based on the table above, the average implementation rates for the TPS learning model by teachers reached 97.06%, with one aspect not used in the research and achieving an excellent rating. For students, the implementation rate was 94.38%. Therefore, it can be concluded that the implementation percentage of the TPS learning model aligns well with the observed aspects. Observation results for experimental group 2 can be seen in the following table.

Table 5. Implementation Results for Experiment 2 Class Teachers

	Percentage			**Criteria**
	Meeting I	**Meeting II**	**Average**	
Teacher	93,67	100	96,83	Very Good

Table 6. Experimental Class 2 Student Implementation Results

	Percentage					**Criteria**
	Meeting 1		**Meeting 2**		**Average**	
	Observer 1	**Observer 2**	**Observer 1**	**Observer 2**		
Student	89,90	86,97	87,39	82,35	86,66	Very Good

Based on the table above, the average implementation of learning with the GI learning model for teachers reached 96.83% with very good criteria, and for students it reached 86.66, so it can be concluded that the percentage of implementation of learning with the GI Learning Model is in accordance with the aspects stated observed.

After carrying out the learning in the two classes, the researcher then gave a posttest which contained indicators of the ability to understand mathematical concepts. The average posttest results for each indicator of the ability to understand mathematical concepts for students in experimental class 1 and experimental class 2 can be seen in the following table.

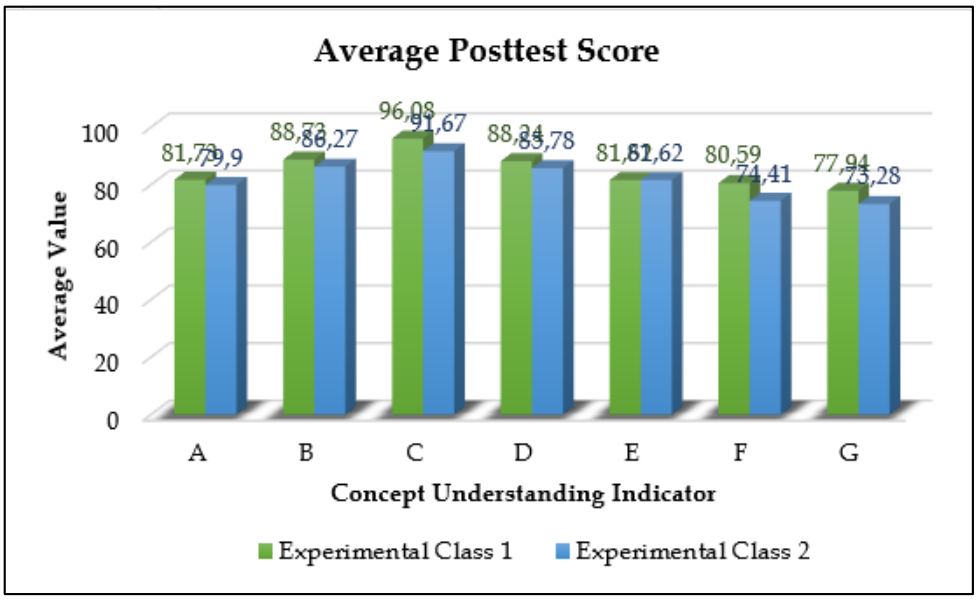

Figure 1. Average posttest score on the Concept Understanding Indicator

Based on the picture above, it can be seen that the highest posttest average score is indicator C with a score of 96.08 in experimental class 1 with very good criteria and 91.67 in experimental class 2 with very good criteria. Meanwhile, the lowest average value was for indicator G with a value of 77.94 in experimental class 1 with good criteria and 73.28 in experimental class 2 with good criteria.

The next step is to carry out prerequisite tests on the posttest results of the two classes, where the tests include normality and homogeneity tests. The normality test in the two classes is presented in the following figure.

Table 6. Normality Test Results

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Eksperimen1	.136	34	.110	.957	34	.202
Eksperimen2	.129	34	.166	.953	34	.155

a. Lilliefors Significance Correction

Based on the table above, it can be seen that the results of the Normality test with Shapiro-Wilk in experimental class 1 got a sig. value 0.202 > 0.05 and experimental class 1 got a sig. value 0.155 > 0.05, so it can be concluded that the two classes have a normal distribution. The Homogeneity test can be presented in the following table.

Table 7. Homogeneity Test Results

Test of Homogeneity of Variances

		Levene Statistic	df1	df2	Sig.
Nilai	Based on Mean	2.847	1	66	.096
	Based on Median	2.850	1	66	.096
	Based on Median and with adjusted df	2.850	1	62.551	.096
	Based on trimmed mean	2.918	1	66	.092

Based on the image above, it can be seen that the results of the Homogeneity test with Leavene Statistics get a sig value. 0.096 > 0.05, so it can be concluded that the two classes are homogeneous. After carrying out the prerequisite tests (normality and homogeneity), then carry out a hypothesis test, where the first hypothesis test is obtained.

$$t_{count} = \frac{\overline{X} - \mu_0}{\frac{s}{\sqrt{n}}} = \frac{83{,}88 - 75}{\frac{4{,}42}{\sqrt{34}}} = \frac{8{,}88}{\frac{4{,}42}{5{,}83}} = \frac{8{,}88}{0{,}76} = 11{,}68$$

Next search $t_{tabel} = t_{(\alpha,n-1)} = t_{(0{,}05,34-1)} = t_{(0{,}05,33)} = 1{,}69$. Because $t_{count} > t_{table}$ or 11.68 > 1.69 then H_0 is rejected. It can be concluded that mathematics learning using the TPS type cooperative learning model is effective on the ability to understand mathematical concepts of class VII students at Dr. Wahidin Mlati Junior High School.

In the second hypothesis test, it was obtained:

$$t_{count} = \frac{\overline{X} - \mu_0}{\frac{s}{\sqrt{n}}} = \frac{80{,}23 - 75}{\frac{5{,}92}{\sqrt{34}}} = \frac{5{,}23}{\frac{5{,}92}{5{,}83}} = \frac{5{,}23}{1{,}01} = 4{,}92$$

Next search $t_{table} = t_{(\alpha,n-1)} = t_{(0{,}05,34-1)} = t_{(0{,}05,33)} = 1{,}69$. Because $t_{count} > t_{table}$ or $4{,}92 \geq 1{,}69$ then H_0 is rejected. It can be concluded that mathematics learning using the GI type cooperative learning model is effective on the ability to understand mathematical concepts of class VII students at Dr. Wahidin Mlati Junior High School.

In the third hypothesis test, it was carried out to find out whether there was a difference in the average ability to understand the concepts of class VII students at Dr. Wahidin Mlati Junior High School on triangle material and which is better between the average problem solving ability using the TPS type cooperative learning model and the average students' conceptual understanding ability using the GI type cooperative learning model. The results of the third hypothesis test were obtained.

$$t_{count} = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{(n_1-1)s_1^2 + (n_2-1)s_2^2}{n_1+n_2-2}\left(\frac{1}{n_1}+\frac{1}{n_2}\right)}}$$

$$t_{count} = \frac{83{,}88 - 80{,}23}{\sqrt{\frac{(34-1)19{,}62 + (34-1)35{,}09}{34+34-2}\left(\frac{1}{34}+\frac{1}{34}\right)}}$$

$$t_{count} = \frac{3{,}65}{\sqrt{\frac{647{,}46 + 1193{,}7}{66}\left(\frac{2}{34}\right)}}$$

$$t_{count} = \frac{3{,}65}{\sqrt{27{,}89(0{,}058)}}$$

$$t_{count} = \frac{3{,}65}{\sqrt{1{,}62}} = \frac{3{,}65}{1{,}27} = 2{,}87$$

Next search $t_{table} = t_{\left(\frac{\alpha}{2}, n_1+n_2-2\right)} = t_{(0{,}025,66)} = 1{,}99$

Because $t_{count} > t_{table}$ is 2.87 > 1.99, it can be concluded that H_0 is rejected. So it can be concluded that the TPS type cooperative learning model is more effective than the GI type cooperative learning model in understanding mathematical concepts for class VII students at Dr. Wahidin Mlati Junior High School on triangle material.

DISCUSSION

Based on the research findings, the researcher conducted a test and data analysis of conceptual understanding ability scores to determine that both classes were normally distributed and homogeneous at the beginning of the study, which determined the suitability of using these classes. This is in line with research Imam et al. (2022), Nurhayati et al. (2022) and Sholikin et al. (2022), where researchers conducted an initial test first to determine the initial abilities of the student.

After analysis, classes VII C and VII D, each consisting of 34 students, were found to have normally distributed and homogeneous data. Using SPSS-25 software, class VII C had a significance level of sig. = 0.202 > 0.05, indicating normal distribution, and class VII D had a significance level of sig. = 0.155 > 0.05, also confirming normal distribution. Furthermore, homogeneity testing yielded a significance level of sig. = 0.096 > 0.05 for both classes, indicating they were homogeneous. Subsequently, using simple random sampling, the researcher selected class VII C as experimental group 1 and class VII D as experimental group 2.

Before testing, the post-test instrument was piloted with class VIII C, consisting of 34 students who had received appropriate materials for the post-test. The pilot test results were analyzed to determine validity, reliability, item discrimination, and difficulty index. Once deemed valid and reliable, the post-test instrument was used for this study, this corresponds to Elzeky et al. (2022), Laupichler et al. (2022), Tseng et al. (2022) and Siswanto et al. (2024).

In experimental group 1, learning utilized the TPS model over two sessions, while experimental group 2 used the GI model for the same number of sessions. Each session in both groups was observed by three observers. Observations of mathematics learning implementation using the TPS model showed that in the first

session, the average teacher implementation rate was 97.06% with an excellent rating, and the student implementation rate was 94.38%, also rated as excellent. Meanwhile, using the GI model in experimental group 2, the average teacher implementation rate was 97.06% with an excellent rating, and the student implementation rate was 86.66%, also rated as excellent. Thus, it can be concluded that the implementation percentages of the TPS and GI learning models align with the observed aspects.

Students completed the post-test after completing their respective learning sessions in experimental groups 1 and 2. This post-test aimed to measure the mathematical conceptual understanding abilities of students in experimental group 1 after learning with the TPS model and experimental group 2 after learning with the GI model.

Normality tests for the post-test scores in experimental group 1 yielded a significance level of sig. = 0.551 > 0.05, and for experimental group 2, sig. = 0.625 > 0.05, indicating normal distribution of post-test scores in both classes. Homogeneity tests for post-test scores yielded a significance level of sig. = 0.096 > 0.05, indicating homogeneous variances between the two classes. Therefore, with the prerequisites met, t-tests were conducted to address the hypothesis (Hadijah et al., 2022; Kishore & Jaswal, 2022; Rohmawati & Fathoni, 2022).

In the first hypothesis test, it will be proven that $H_0 = \mu_1 \leq 75$ which shows that the TPS type cooperative learning model is effective on the ability to understand mathematical concepts). From the calculations, it is obtained that $t_{count} = 11{,}68$ and the $t_{tabel} = 1{,}69$ because $t_{count} > t_{table}$ then H_0 is rejected, which means that mathematics learning using the TPS type cooperative learning model is effective on the ability to understand mathematical concepts of class VII students at Dr. Wahidin Mlati Junior High School pada studied triangles with an overall average score of more than 75, namely 83.88.

In the second hypothesis test, it will be proven that $H_0 = \mu_2 \leq 75$ which shows that the GI type cooperative learning model is effective on the ability to understand mathematical concepts. From the calculations, it is obtained that $t_{count} = 4{,}92$ and the $t_{tabel} = 1{,}69$ because $t_{count} > t_{table}$ then H_0 is rejected, which means that mathematics learning using the GI type cooperative learning model is effective on the ability to understand mathematical concepts of class VII students at Dr. Wahidin Mlati Junior High School pada studied triangles with an overall average score of more than 75, namely 80.23.

In testing the third hypothesis, $H_0 = \mu_1 \leq \mu_2$ will be proven, which shows that the TPS learning model is no more effective than the GI type cooperative learning model on the ability to understand mathematical concepts. From the calculations obtained $t_{count} = 2{,}87$ and $t_{table} = 1{,}99$ because $t_{count} > t_{table}$ is 2.87 > 1.99, it can be concluded that H_0 is rejected and this means that the TPS type cooperative learning model is more effective than the GI type cooperative learning model in understanding concepts. mathematics, class VII students at Dr. Wahidin Mlati Junior High School on triangle material.

CONCLUSIONS AND RECOMMENDATIONS

Based on the results and discussion, it can be concluded that: (1) The TPS learning model is effective for the ability to understand mathematical concepts in class VII Dr. Middle School. Wahidin Mlati in triangle material with an overall average score of more than 75, namely 83.88; (2) The GI learning model is effective for the ability to understand mathematical concepts for class VII SMP Dr. Wahidin Mlati in triangle material with an overall average score of more than 75, namely 80.23; (3) The TPS type learning model is more effective than the GI type learning model for understanding mathematical concepts in class VII students at Dr. Wahidin Mlati Junior High School on triangle material.

FURTHER STUDY

Researchers can use TPS and GI type cooperative learning models because they can improve students' ability to understand concepts. Apart from that, future researchers can apply other cooperative learning models to improve students' ability to understand concepts.

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