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The Level of Effectiveness of TPS and Conventional Methods Judging from Students' Geometry Learning Results Using the N-Gain Test

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ABSTRACT

The low results of student geometry learning require a trial of the *think-pair-share* method as a replacement for conventional methods. This research aims to: (1) compare the level of effectiveness of applying the think-pair-share method with conventional learning in improving student geometry learning outcomes, and; (2) determine whether or not there is a significant effect from using the two methods. The method used is quasi-experimental with a nonequivalent pretest-posttest control group design involving an experimental group and a control group. Each group consisted of 23 class VII students selected non-randomly from the population. Data was taken using a geometry learning outcomes test instrument. Data were analyzed using *the N-Gain Score* test, the results of the calculations were converted into interpretation categories for *N-Gain* effectiveness to be concluded. Research findings: (1) the application of both methods was "ineffective", as shown by the calculation results of the average *N-Gain score (%)* for the experimental group of 38.112% and the control group of 30.636%, and; (2) based on the results of the hypothesis test, it was concluded that there was no significant influence from the application of the two methods on improving student geometry learning outcomes. The implication of this finding is that it is not recommended to apply the think-pair-share method if it is only focused on improving the geometry learning outcomes of class VII students, but it can still be applied for the purpose of developing students' collaboration skills.
Keywords: Geometry, N-*Gain Score Test, Think-Pair-Share*

ABSTRAK

Rendahnya hasil belajar geometri siswa membutuhkan uji coba metode *think-pair-share* sebagai pengganti metode konvensional. Penelitian ini bertujuan: (1) membandingkan tingkat efektifitas penerapan metode *think-pair-share* dengan pembelajaran konvensional terhadap peningkatan hasil belajar geometri siswa, dan; (2) mengetahui ada atau tidaknya pengaruh yang signifikan dari penggunaan kedua metode tersebut. Metode yang digunakan yaitu *quasi eksperimen* dengan desain *nonequivalent pretest-posttest control group* yang melibatkan kelompok eksperimen dan kelompok kontrol. Setiap kelompok terdiri dari 23 siswa kelas VII yang dipilih secara non acak dari populasi. Data diambil menggunakan instrumen tes hasil belajar geometri. Data dianalisis menggunakan uji *N-Gain Score*, yang hasil perhitungannya dikonversi ke dalam kategori interpretasi efektivitas *N-Gain* untuk disimpulkan. Temuan penelitian: (1) penerapan kedua metode "tidak efektif", yang ditunjukkan oleh hasil perhitungan rata-rata skor *N-Gain* (%) kelompok eksperimen sebesar 38,112% dan kelompok kontrol sebesar 30,636%, dan; (2) berdasarkan hasil uji hipotesis disimpulkan tidak ada pengaruh yang signifikan dari penerapan kedua metode terhadap peningkatan hasil belajar geometri siswa. Implikasi dari temuan ini adalah tidak direkomendasikannya penerapan metode *think-pair-share* jika hanya difokuskan untuk meninngkatkan hasil belajar geometri siswa kelas VII, namun masih bisa diterapkan untuk tujuan mengembangkan kemampuan kolaborasi siswa.
Kata kunci: Geometri, Uji *N-Gain Score, Think-Pair-Share*

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Introduction

Collaboration skills have been identified by world institutions as one of the skills that students really need in the future (National Education Association (NEA), 2019; OECD, 2019; UNESCO, 2016). This ability to collaborate is actually general, because every individual is expected to have it if they want to be successful at work and live a successful life in society (Evans, 2020). Collaboration and communication skills as well as leadership abilities are included in the interpersonal competency category whose formation process can be carried out through teaching and learning activities in schools (National Research Council (NRC), 2012). To respond to this, Kim et al., (2019) suggest that every teacher who will teach should think about a quality learning process, as well as think about learning outcomes that are tailored to students' needs after graduation. One of these needs is mastering collaboration skills.

According to Evans (2020), students' collaboration abilities can be seen when they are: (1) planning and making group decisions; (2) communicating thoughts to group members, (3) contributing resources, ideas, and efforts that support group members, and (4) monitoring, reflecting, and adapting things that are beneficial to the group. These collaborative activities will emerge and continue to increase if they are supported by the use of appropriate learning methods by teachers in schools. However, there are other things that teachers need to consider when deciding on learning methods, namely the academic goals that must be achieved, generally in the form of improving understanding and improving students' learning outcomes (Alifah, 2019; Fahrurrozi et al., 2021; Khoerunnisa et al., 2020; Warsita, 2018). Thus, apart from student achievement in the aspect of collaboration skills, teachers also need to pay attention to the extent to which students' understanding and learning outcomes have increased.

At this stage, researchers see the need to trial certain learning methods which have been recognized by many parties as being able to facilitate the development of students' collaboration skills. Several research results conclude that the application of the *think-pair-share (TPS)* method can facilitate the formation of students' collaboration skills. Among them are research conclusions from (Budiarta & Krismayani, 2014; Fauzi et al., 2021; Sajidan et al., 2023), which generally state that the implementation of *think-pair-share* (TPS) measures has a positive impact on increasing student collaboration activities. Lyman, F. (1987) himself as the designer of the *think-pair-share (TPS)* method has said that this strategy was deliberately designed to improve students' collaborative skills and share ideas and thoughts with other students. For this purpose, Lyman, F. (1987) designed learning with stages: (1) *Think* stage, where the teacher provides a problem for each student to think about the solution; (2) *Pair* stage, where students are asked to discuss in pairs to determine the most appropriate solution among the alternative solutions that each has thought of, and; (3) *Share* stage, where students are asked to share the solutions they have discussed with their partners with their classmates. These learning steps have been proven to be useful for improving students' collaboration skills, but the question still arises: "Are the *think-pair-share (TPS)* learning stages effective in improving students' mathematics learning outcomes?" This question needs to be asked considering that mathematics has been seen as the most difficult and abstract subject, which requires more teacher involvement to instill understanding in students, especially for students at the basic education level (Akhter & Akhter, 2018; Raj Acharya, 2017).

Mathematics learning in schools is divided into several materials, therefore, to answer the question above, researchers need to set boundaries regarding the mathematics learning outcomes that will be measured, namely the results of learning geometry taught in class VII. Geometry is a branch of mathematics that focuses on studying shape, size and position (Coxford & Usiskin, 1975). Geometry material was chosen because the educational curriculum content in Indonesia places geometry material at 42% of all mathematics material taught at junior high school level (Suwito, 2018). So whatever the results of this research will produce information that will have a big influence on the development of mathematics education, especially in Indonesia. Another reason is based on the results of the analysis conducted by Afifah et al., (2022); Elsa et al., (2022); Elsa & Suhendra (2022); Laviona et al., (2022); Prasetyo & Masduki (2023) which shows that class VII students still often make mistakes when trying to solve everyday problems related to geometry. This shows that there is still a need for studies and trials of certain learning methods that focus on improving students' geometry learning outcomes. Moreover, initial observations carried out by researchers at one of the schools in Purworejo also showed that geometry learning outcomes were relatively low. This is shown by the students' geometry learning test results in the previous year which only reached 43.6. Another reason for choosing geometry material is because geometry material has the potential to be easier for students to understand than material from other branches of mathematics (D'Augustine & Charles H, 1992), so it is very possible if geometry learning is carried out using the *TPS* method.

Based on the reasons above, the geometry learning results of class VII students can later be used as a benchmark for whether the *TPS* method applied in this research is effective or not. The level of effectiveness of implementing the *TPS* method will be

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known after comparing it with the effectiveness of implementing other learning methods that teachers usually apply in schools, namely conventional methods. So the formulation of the research objectives to be achieved is to find out: (1) which method is more effective between the *TPS* method and conventional methods when viewed from students' geometry learning outcomes, and; (2) whether there is a significant difference in influence between the two methods on students' geometry learning outcomes.

Similar research was conducted by Afthina et al., (2017) who tried to implement the *TPS* method in geometry learning with the topic of cubes and blocks in class VIII. Another study was by Oluwanife Segun et al., (2022) who also applied the TPS method to the topic of circular geometry taught in class XII. The novelty value of this research is in the geometry topic used, namely triangles and quadrilaterals which are taught in class VII. The results of this research will later become very important information for mathematics teachers, including regarding the design of the *TPS* method which can be adapted by them, especially those who want to teach geometric concepts. Another benefit is that teachers get information about factors that can influence the level of effectiveness of applying the *TPS* method in learning geometry, especially on the topic of triangles and quadrilaterals.

Research Methods

The aim of this research is focused on finding out: (1) which method is more effective between the *TPS* method and conventional methods in terms of students' geometry learning outcomes, and; (2) whether or not there is a significant difference in influence between the *TPS* method and conventional methods on students' geometry learning outcomes. The research objectives were achieved using a *quasi-experimental* method with a *nonequivalent pretest-posttest control group* design. This research design requires pretest and posttest data from 2 sample groups, namely the experimental group and the control group (Sugiyono, 2018). The experimental group and control group each consisted of 23 students. The sample group was taken non-randomly from 5 groups of students from one of the junior high schools in Purworejo-Indonesia which were used as the research population, that is, the researcher only accepted sample conditions from groups or classes that had been previously formed, in this case formed by the school. The instrument used to collect research data is a geometry learning outcomes test instrument which consists of 10 multiple choice questions which have been declared valid and reliable by experts who act as validators of the test instrument. These ten questions will measure geometry learning outcomes related to mastery of square and rectangular concepts. In general, the research procedures carried out are presented in Figure 1.

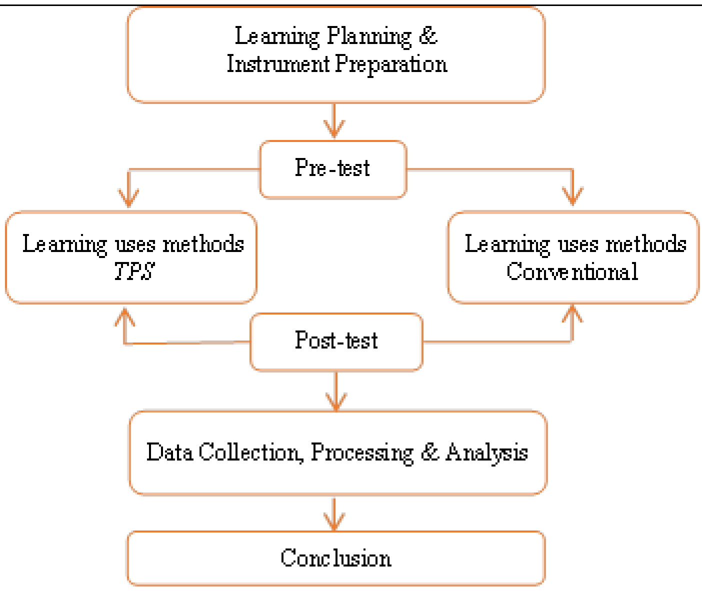

Figure 1. *Nonequivalent Pretest-Posttest Control Group* Design
(adapted from Sugiyono, 2018)

Figure 1 shows the pre-test carried out on the two sample groups before learning began. According to the research design, learning was planned to take place in 3 meetings. The conventional group will learn following the learning plan previously set by the teacher. The experimental group will learn using the think-pair share (TPS) method where students will collaborate to answer questions given by the teacher. Steps for learning activities in class; (1) the teacher will ask questions as a stimulus for the geometry topic being studied; (2) students are given 5-10 minutes to independently think about ideas or alternative answers to questions given by the teacher; (3) students are directed to write temporary answers on the paper or worksheets they have; (4) the teacher directs students to pair up with one of their friends; (5) students are asked to exchange ideas with friends who are their partners; (6) students are asked to analyze answers that are the same or similar to their partner's answers, and are also asked to analyze different answers for further discussion; (7) then students are asked to discuss whose answer or idea is most relevant to answering the question, and (8) after completing the discussion and choosing the best idea, students are asked to share it with all groups.

After the experimental and control groups completed all stages of geometry learning, it ended with a posttest. Pretest and posttest data were analyzed using the *N-Gain Score* test with the formula (Equation 1):

$$N\ Gain = \frac{posttest\ score - pretest\ score}{ideal\ score - pretest\ score} \quad (1)\ \text{(Hake, R.R, 1999)}$$

The *N-Gain Score* test calculation is carried out using SPSS software. The results of the *N-Gain Score* calculation is then converted into interpretation categories of *N-Gain* effectiveness which are presented in Table 1.

Table 1. Interpretation of Effectiveness Categories N-Gain (Hake, R.R, 1999)

Average Percentage (%)	Interpretation
< 40	Ineffective
40-55	Less effective
56-75	Effective enough
>76	Effective

Table 1 shows the interpretation of the effectiveness categories which will be used as a reference to conclude which method is more effective in improving students' geometry learning outcomes.

Further data analysis is aimed at determining whether or not there are significant differences in influence between the TPS method and conventional methods. Analysis was carried out on the N-Gain Score value data using the independent t-test which was preceded by the Shapiro-Wilk normality test and the Levene's Test of homogeneity as pre-requisite tests. The conclusion regarding whether or not there is a significant difference in influence between the TPS method and conventional methods is known after testing the hypothesis

Result and Discussions

Learning Process using the TPS Method

In accordance with established research procedures, the pretest was given before the start of the geometry learning activity, the results of the pretest can be seen in Table 2. Furthermore, geometry learning in the experimental group and control group was each carried out in 3 meetings. The distribution of teaching materials at each meeting is: the first meeting discusses the concepts of rectangles and squares; the second meeting discussed the concepts of trapezoids and parallelograms, and; The third meeting discussed the concepts of rhombuses and kites. The stages of implementing the TPS method in the experimental class according to the steps in Figure 2.

The process flow in Figure 2 shows that each meeting begins with the teacher asking students questions about geometric concepts. Next, the teacher gives time to students to think about answers. Students who already have alternative answers are then directed to choose one of their friends who they will use as their discussion partner. If each discussion pair has succeeded in concluding an answer, the teacher will provide an opportunity to share the answer by presenting it to all students in the class. During the learning process, researchers make direct observations and record things that can be used as research data.

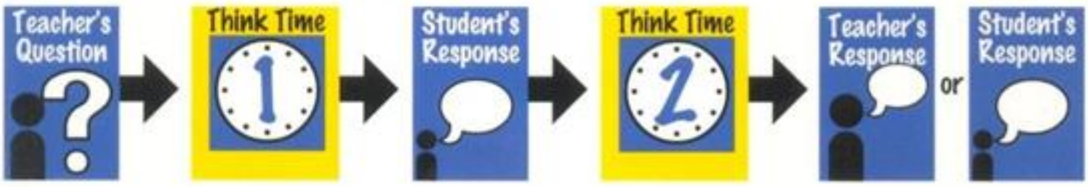

Figure 2. Stages of the Think Pair Share Method (adapted from Lyman, F., 1987; Lyman, T., et al., 2023)

Analysis of the Effectiveness of TPS and Conventional Methods

Implementation of learning using *TPS* and conventional methods produces pretest and posttest data as presented in Table 2.

Table 2. Pretest and Posttest Results Data

Number	Experimental Group		Control Group	
Student	Pretest	Posttest	Pretest	Posttest
1	60	70	40	55
2	60	60	60	60
3	40	85	35	35
4	30	55	40	40
5	60	85	35	65
6	60	75	40	80
7	55	85	35	75
8	50	80	40	60
9	30	50	50	80
10	45	80	55	65
11	60	70	50	60
12	75	75	35	55
13	40	70	20	50
14	50	75	20	70
15	30	45	35	40
16	30	70	55	65
17	30	45	40	65
18	45	75	40	55
19	35	80	50	60
20	70	70	35	55
21	35	55	35	75
22	45	50	50	65
23	40	60	55	55
Average	46,74	68,04	41,30	60,22

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The data in Table 2 was analyzed using the *N-Gain Score* test calculation with the aim of finding out which method is more effective in improving student geometry learning outcomes. With the help of *SPSS* software, you can find out the *N-Gain Score* (%) for each student, the maximum *N-Gain Score* (%), the minimum *N-Gain Score* (%) and the average *N-Gain Score* (%), as presented in the Table. 3.

Table 3. N-Gain Score Test Results for Experimental Group and Control Group

Experimental Group		Control Group	
Number Student	*N-Gain Score* (%)	Number Student	*N-Gain Score* (%)
1	25	1	25
2	0	2	0
3	75	3	0
4	35,71	4	0
5	62,5	5	46,15
6	37,5	6	66,67
7	66,67	7	61,54
8	60	8	33,33
9	28,57	9	60
10	63,64	10	22,22
11	25	11	20
12	0	12	30,77
13	50	13	37,5
14	50	14	62,5
15	21,43	15	7,69
16	57,14	16	22,22
17	21,43	17	41,67
18	54,55	18	25
19	69,23	19	20
20	0	20	30,77
21	30,77	21	61,54
22	9,09	22	30
23	33,33	23	0
Mean	38,112	Mean	30,6336
Minimum	0,00	Minimum	0,00
Maximum	75	Maximum	66,67

Table 3 shows the average *N-Gain Score (%)* value for the experimental group of 38.112%, with a minimum *N-Gain score (%)* value of 0% and a maximum of 75%. Meanwhile, the average *N-Gain Score (%)* for the control group was 30.636, with a minimum *N-Gain Score (%)* value of 0% and a maximum of 66.67%. The average value of the *N-Gain Score (%)* is then converted into an *N-Gain Effectiveness Category Interpretation* as presented in Table 1. Based on the *N-Gain Effectiveness Category Interpretation* in Table 1, the average *N-Gain* value of the experimental group (38.112%)

and the control group (30.636%) were included in the ineffective category. Thus, it can be interpreted that the *TPS* learning method and conventional learning are both "ineffective" in improving the geometry learning outcomes of class VII students, especially on the topic of triangles and quadrilaterals.

Analysis of Differences in Influence

At this stage, we will compare whether there is a significant difference in influence between the application of the *TPS* method and the conventional method using the independent t-test technique for the *N-Gain Score (%).* Before carrying out the *t-Independent* test, it must be preceded by a normality test and a homogeneity test as a prerequisite.

The normality test was carried out using *the Shapiro-Wilk* normality test. The basis for the test decision used is if the Sig. > 0.05 then the data is normally distributed, conversely if the Sig value <0.05 then the data is not normally distributed. The results of the normality test carried out with the help of *SPSS software* are presented in Table 4.

Table 4. *Shapiro-Wilk* Normality Test Results

Data	*Shapiro-Wilk*		
	Statistic	Df	Sig.
N-Gain Score (%) Experimental Group	0,9443	23	0,203
N-Gain Score (%) Control Group	0,924	23	0,82

Table 4 shows that the experimental group has a Sig value. 0.203 > 0.05, and the control group had a Sig.0.82 > 0.05. Thus, both data from the control class and the experimental class are both normally distributed. Next, a homogeneity test was carried out using *Levene's Test* for Equality of Variance. The basis for the test decision determined is if the Sig value. > 0.05 then the data variance is homogeneous, conversely if the Sig value <0.05 then the data variance is not homogeneous. The results of the homogeneity test carried out with the help of SPSS software are presented in Table 5.

Table 5. *Levene's* Homogeneity Test Results

Data	*Levene's Test* for Equality of Variances	
	F	Sig.
N-Gain Score (%) (Equal variances assumed)	0,597	0,444

Table 5 shows the Sig value. 0.444> 0.05, it can be concluded that the variance of the N-Gain Score (%) data for the experimental group and the control group is the same or

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homogeneous. Thus, the independent t-test for N-Gain Score (%) can be carried out. The hypothesis used is:

H_0: There is no significant difference in influence between the use of the TPS method and conventional learning on improving students' geometry learning outcomes.
H_1: There is a significant difference in influence between the use of the TPS method and conventional learning on improving geometry learning outcomes.
The basis for the test decision used is if the Sig. (2-tailed)> 0.05 then H_0 is accepted and H_1 is rejected, conversely if the Sig. (2-tailed) < 0.05 then H_0 is accepted and H_1 is rejected.

The results of the *t-Independent N-Gain Score* test with the help of *SPSS Software* is presented in Table 6.

Table 6. *Independent N-Gain Score t-Test* Results

Data	*T-test for Equality of Means*						
	t	*df*	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
						Lower	Upper
N-Gain Score (%)	1,127	44	0,266	7,47764	6,63473	-5,89378	20,84907

Table 6. shows the Sig value. (2-tailed) = 0.266> 0.005 so that the test decision taken is that H_0 is accepted and H_1 is rejected. Thus, it can be concluded that there is no significant difference in influence between the use of the *TPS* method and conventional methods on improving the geometry learning outcomes of class VII students, especially on the topic of triangles and quadrilaterals.

At this stage the researcher has completed the data analysis stage which aims to compare the level of effectiveness of using the *think-pair-share (TPS)* method with conventional methods. The average achievement of the *N-Gain Score (%)* in the experimental group was 38.112% and in the control group it was 30.636%, which if this achievement is converted into an Interpretation of the *N-Gain Effectiveness Category* then both fall into the "ineffective" category. Based on the results of the N-Gain Score calculation and its interpretation, the researchers showed that the two methods were both "ineffective" when applied to geometry learning. If we look at the average *N-Gain Score (%)* it can be seen that the experimental group has better performance, namely there is an average difference of: 38.112% - 30.636% = 7.476%, but in general the conclusion that can be drawn is: application of the method *think-pair-share (TPS)* is not effective or no more effective than using conventional methods, especially when applied to geometry learning.

In the next stage, researchers have completed data analysis which aims to determine whether there is a significant difference in influence between the *TPS* method and conventional methods on students' geometry learning outcomes. The results of the hypothesis test carried out using an independent t test concluded that there was no significant difference in influence between the use of the *TPS* method and conventional learning on improving student geometry learning outcomes. So at this stage the researchers have been able to show that the application of the *think-pair-share (TPS)* method has not been able to have a significant impact on improving or improving students' geometry learning outcomes.

If we refer to the theoretical framework and research background, namely the hope that the trial application of the *think-pair-share (TPS*) method can increase student collaboration activities and at the same time improve students' geometry learning outcomes, it turns out that based on the results of this research the application of this method has not been effective and does not have a significant influence on improving student geometry learning outcomes. The results of this research are apparently not in line with the research results of Afthina et al., (2017) which concluded that the application of the *TPS* method which is integrated with the *realistic mathematics education (RME)* approach is better than the application of conventional methods, when viewed from learning achievement student geometry. According to Afthina et al., (2017), these positive results were influenced by the geometric content with the *RME* approach integrated in the *TPS* steps which succeeded in encouraging students to be actively involved in the process of understanding the material. Apart from that, students also feel that their mathematics learning is more meaningful. Meanwhile, research by Oluwanife Segun et al., (2022) which examined the application of the *TPS* method showed results that were relatively in line with the results of this study. The results of the research show that there is no influence between students' interactive behavior when following the *TPS* steps and student learning outcomes on the topic of circle geometry. Based on these findings. Oluwanife Segun et al., (2022) suggest that teachers should be more involved in their teaching practices. Based on the results of this research, researchers do not recommend using the *TPS* method in learning geometry, especially on the topic of triangles and quadrilaterals.

The weakness of the *TPS* method was actually revealed by Zakirman et al., (2020) who stated that teachers often experience difficulties at the Think stage, namely when trying to introduce problems to students, especially elementary school age students. Referring to this opinion, it is possible that the ineffectiveness of the application of the *TPS* method is caused by the age development level of the students who are the subjects of the research. The age of class VII students who are the subjects of this research are not yet fully mature and this has the potential to be one of the reasons for their low ability to understand geometric problems presented by the teacher. Other weaknesses of the TPS learning method are: (1) the relatively large number of paired groups makes it difficult for teachers to monitor, especially if many students submit reports and must respond immediately; (2) not many ideas emerge from students, especially if each pair of students acts passively, and; (3) there is no mediator if there is disagreement between pairs of student groups (Shoimin, 2019). So based on these findings, in the next application of the *TPS* method, teachers need to consider aspects of their students' age development, as well as the need to integrate mathematical content aimed at making learning more meaningful.

Conclusion

Based on the data analysis and discussion that has been presented, it can be concluded that the application of the TPS method and conventional methods are both ineffective if focused on the aim of improving the geometry learning outcomes of class VII students, especially on the topic of triangles and quadrilaterals. This is shown by the results of the calculation of the average value of the *N-Gain Score (%)* for the experimental group of 38.112% and the control class of 30.636%, where both scores, if converted into an Interpretation of the *N-Gain* Effectiveness Category, are in the "ineffective" category. After testing the hypothesis, it was concluded that there was no significant difference in influence between the use of the think-pair-share method and conventional methods on improving the geometry learning outcomes of class VII students. Based on these results, it is also recommended that teachers consider the age aspect of their students when implementing the *TPS* method. Apart from that, it is necessary to integrate mathematical content which aims to facilitate student understanding and so that students experience more meaningful learning.

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