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The Comparison of Students' Mathematical Problem Solving Ability through Students Teams Achievement Division (STAD) and Problem Based Learning (PBL)

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ABSTRACT

The purpose of the study was to determine the comparison of students' mathematical problem-solving abilities through STAD and PBL learning models. This research was an experimental study with a nonequivalent post-test only control group design. The population of this study was all grade IX students of SMP Negeri 1 Kolaka for the 2018/2019 academic year, which consisted of eight classes totaling 200 students. The sample selection was done by using the cluster sampling technique so that two classes IXD were obtained class IX_D as the class that used the STAD model and class IX_A as the class that used the PBL model. Class IX_D has 25 students, and IX_A has 26 students. The research data was collected through documentation, observations, and a problem-solving ability test. The research data in this study were analyzed using descriptive and inferential statistics. The results showed that descriptively the mathematical problem-solving ability (MPSA) of students in the STAD and PBL learning models showed an average score of 70 (good) and 69.34 (enough). Inferentially from the prerequisite test, the data obtained were normally distributed, and the variance of the two data was homogeneous. The hypothesis was tested using an independent sample t-test. The results of hypothesis testing indicate that there was no significant difference between students' MPSA with the application of the STAD learning model and the PBL model. So it was concluded that there was no difference in students' mathematical problem-solving abilities in using the STAD learning model or the PBL model.

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1. INTRODUCTION

Mathematics is a basic science that plays an important role in everyday life and the progress of science and technology. Mathematics needs to be learned and mastered by elementary school to university students (Kusmaryono, 2018) because mathematics is a medium of thought that leads to logical, systematic critical, and rational thinking patterns (Firdaus et al., 2015). One of students' abilities in learning mathematics in schools in the 2013 curriculum is solving mathematical problems (Ariandi, 2016). The direction of mathematics learning is no longer oriented to cognitive abilities but has been centered on the ability to solve mathematical problems related to the life problems it faces (Rohmawati et al., 2019). Therefore problem-solving skills are fundamental in learning mathematics to develop students' thinking skills.

Problem-solving ability (PSA) is expressed as the ability of students to understand, plan, and solve the problems they face through appropriate strategies (Nur & Palobo, 2018; Utami & Wutsqa, 2017; Cahyani & Setyawati, 2016). By understanding the problem-solving stages, students will find it easier to solve both easy questions and moderate to more complex ones (Dewi et al., 2021). Through problem-solving activities, problems in non-routine problems, finding patterns, communicating ideas, concluding, etc., become easy to develop (Mariam et al., 2019). In addition, mathematical problem-solving skills can usually be used to solve other problems for mathematics or other things outside of mathematics itself (Reski et al., 2019). Thus PSA has an essential role in helping students to more easily understand mathematics lessons and solve problems they face in everyday life.

Students' mathematical problem-solving abilities (MPSA) are still relatively low (Cahyani & Setyawati, 2016; Rianti, 2018) and require improvement (Nur & Palobo, 2018). The research of Kamilah & Imami (2019) concluded that the level of MPSA of grade VIII students in one of the junior high schools in Karawang Regency was still low where only 53% of students could understand the problem, 38% of students were able to develop plans, 33% of students implemented plans, and 20% students who can re-examine. International studies that measure students' MPSA still need to be far from expectations. The 2015 Trends in Mathematics and Sciences Study (TIMSS) survey found that Indonesian students were in 44th position out of 49 countries (Mullis et al., 2015). Meanwhile, the 2018 For International Student Assessment (PISA) Program results placed Indonesia at 35th out of 41 countries globally in terms of students' mathematical abilities (OECD, 2018). These results indicate that Indonesian students' mathematical problem-solving ability is still low.

Utami & Wutsqa (2017) state that the average PSA of junior high school students is in low criteria due to poor understanding of information on questions, inappropriate mathematical models, and inaccurate problem-solving. Cahyani & Setyawati (2016) revealed that students' mathematics PSA is low because the learning carried out by teachers so far has not facilitated students in developing their ability to solve problems. Therefore, we need an effort and the right solution to provide space for students to understand and apply PSA appropriately.

One of the efforts to develop student PSA is to improve the learning process by applying appropriate and innovative learning models (Ariandi, 2016; Farman & Chairuddin, 2020). Several innovative learning models can be used, each with advantages and disadvantages. Educators must be MPSAeful in selecting and sorting the learning models used and adapt effective learning models to the characteristics of different students and in different materials (Farman et al., 2021). One alternative learning model that provides opportunities for students to develop their thinking skills in solving problems is the Student Teams Achievement Division (STAD) learning model (Sumbung et al., 2019).

The STAD learning model is the simplest cooperative learning model (Dewi et al., 2021). STAD is a learning model that positions students into heterogeneous groups based on academic ability, gender, and ethnicity (Tambunan et al., 2020). This division aims for each group member to actively work together to contribute to the group's success (Farman et al., 2019). STAD model learning is carried out with the steps (1) conveying learning objectives and motivating students, (2) forming groups, (3) presenting material, (4) studying together in groups, (5) quizzes (evaluation), and (6) awards. team achievement (Tambunan et al., 2020). Through this learning model, students can work together and collaborate, express opinions, help each other, discuss and ask the teacher to solve mathematical problems (Astuti, 2016). Thus, the STAD model, which emphasizes learning with group work, will make it easier for students to accept the material presented by the teacher to improve students' ability to solve mathematical problems.

The study results show that the STAD learning model positively influences PSA. Tambunan et al., (2020) stated that using the STAD learning model was influential on the MPSA of students in class X SMA, with the average MPSA of students in the good category. Suriyani (2019) stated the effect of the STAD model on the MPSA of junior high school students. There was an increase in student MPSA after applying the STAD learning model (Dewi et al., 2021). There are differences in student MPSA in the STAD and Think Pair Share (TPS) models, where the PSA in the STAD model is higher than the TPS (Syafrida & Simanjuntak, 2017).

In addition, other learning models can facilitate students' problem-solving abilities, namely the problem-based learning (PBL) model (Ariandi, 2016; Cahyani & Setyawati, 2016; Reski et al., 2019; Sumartini, 2018). PBL is a learning model designed so that students gain knowledge and are skilled in problem solving and skills to participate in teams (Susilawati, 2019). PBL is based on constructivist theory. Learning begins with presenting real-life problems. Students are then motivated to understand the problem using previously acquired knowledge and experience to form new knowledge and experiences (Chairuddin & Farman, 2019) and develop higher skills (Ariandi, 2016). The steps in PBL consist of problem orientation, managing students, guiding, developing and presenting work, and analyzing and evaluating problem-solving (Brilliyanti et al., 2016). These stages can encourage students to be independent in learning, form their knowledge, and acquire skills from learning (Andriana et al., 2021). Thus the PBL model, through its learning steps, can help students develop mathematical problem-solving skills.

The study results show that the PBL model influences PSA (Ayyubi et al., 2018). PBL research mainly focuses on improving mathematical PSA and comparison with other conventional learning models. The use of the PBL model is effective in improving students' mathematical PSA in Elementary Schools (Gunantara et al., 2014, Nasir, 2016), Junior High Schools (Noviantii et al., 2020), and High Schools (Susilawati, 2019). The MPSA of students who apply the PBL model is higher than those who apply conventional learning (Andriana et al., 2021; Resilona et al., 2018; Sumartini, 2018). The PBL learning model is better than the Discovery Learning model seen from the student MPSA (Hasibuan & Sinaga, 2017). The PBL model is better than the direct learning model for the MPSA of students (Tanti et al., 2020; Yulinar & Suherman, 2019).

Based on the description above, it can be said that the STAD and PBL models influence the MPSA. Previous research only compared the mathematical problem-solving ability between the PBL model and other learning models, apart from the STAD learning model. Likewise, other studies only compare the STAD model with other learning models, apart from the PBL learning model. So it is necessary to investigate which model is better than PBL and STAD in developing student MPSA. Thus, this study aimed to determine the comparison of MPSA between the Student Teams Achievement Division (STAD) and Problem Based Learning (PBL) models.

2. METHODS

The research method should be included in the Introduction. The method explains the research approach, subjects of the study, the conduct of the research procedure, the use of materials and instruments, data collection, and analysis techniques.

The type of research used is experimental research. The study involved two research classes, namely the experimental class (EC), which applied the STAD type cooperative learning model (X1) and the PBL model (X2) to MPSA (O). The research design used the Noneequivalent post-test only control group design. The form of the research design is as follows.

$$EC_{I} : \quad X_1 \quad O_1$$

$$EC_{II} : \quad X_2 \quad O_2$$

The population of this study was all class IX students of SMP Negeri 1 Kolaka in the odd semester of the 2018/2019 academic year, which consisted of eight classes with a total of 200 students. The research sample was selected using a cluster sampling technique. Before taking the sample, a homogeneity test was conducted using Levene's test statistic and showed that the eight classes were homogeneous. Class determination was carried out by class randomization with the record that the first class was STAD class and the second was PBL class. The randomization results were obtained for class IX D as STAD class with 25 students and class IX A as PBL class with 26 students.

This research activity was carried out three times in the learning activity meetings, and the last meeting was the post-test implementation. Data collection in this study was carried out using observation, test, and documentation techniques. Observation activities are carried out in the learning process where there is an observer who observes student activities by filling out the observation sheet that has been provided. Observation aims to obtain data about student activities in learning. Documentation is used to obtain a list of names and the number of students and data on students' math test scores as initial data for determining STAD and PBL classes. The test is carried out after the learning process activities are carried out. The test is used to obtain the student's MPSA score. The test used in this study was a post-test in the form of a description test. This test question consists of 5 questions with indicators determining the solution of the root by factoring (2 questions), determining the solution of the root by completing the perfect square (2 questions), and determining the solution of the root with the ABC formula (1 question). The measurement of this test is based on indicators of problem-solving abilities according to Polya, namely understanding problems, planning solutions, solving problems, and interpreting solutions (Sumartini, 2018). Before the questions were tested on the research subjects, the items were first tested on 34 class IX students at MTs Negeri 1 Kolaka. The results of the post-test test were carried out with the results of SPSS calculations for the Pearson Product Moment correlation coefficient, and it was found that the five items of the mathematical problem-solving ability test were valid. Furthermore, the test questions on mathematical problem-solving ability were tested for reliability with Cronbach's Alpha, 0.736. This means that the reliability of the mathematical problem-solving ability test is included in the high category.

MPSA test data in this study were analyzed using descriptive and inferential analysis techniques. The descriptive analysis presents research data to obtain the test scores' average score (mean), variance, and standard deviation. Mawaddah & Anisah (2015) categorizes MPSA as shown in Table 1.

Table 1. Mathematical Problem Solving Abilities (MPSA) Categories

Score	Category
85 – 100	Very Good
70 – 84,99	Good
55 – 69,99	Enough
40 – 54,99	Less
0 – 39,99	Very Poor

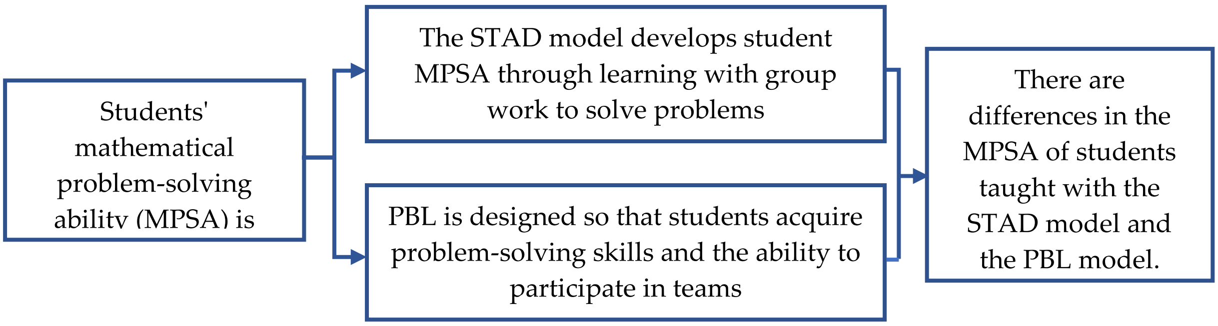
Meanwhile, an observation sheet describes research data about student activity in learning, which contains indicators of activity that students must achieve. Activity indicators that students must achieve are paying attention to teacher explanations, actively asking and answering questions, working together in groups, giving opinions and listening to friends' opinions during discussions, solving problems, presenting discussion results, making conclusions, and conducting evaluations (Zaeni & Hidayah, 2017). The criteria for student activity (Alis, 2020) are presented in Table 2.

Table 2. Category of Student Activity

Percentage	Category
A > 80%	Very Active
60% < A ≤ 80%	Active
40% < A ≤ 80%	Fairly Active
20% < A ≤ 40%	Less Active
A ≤ 20%	Not Active

The inferential analysis is used to test the hypothesis that there is a difference in the mean MPSA of class IX students of SMPN 1 Kolaka in learning the STAD and PBL models and draw conclusions from the data used. Before testing the hypothesis, prerequisites were first tested: the normality test with the Kolmogorov-Smirnov test and the homogeneity test with the F-test. After the prerequisite test, the hypothesis was then tested using the independent sample-t-test. This statistical analysis was used with the help of the SPSS 20 program.

The framework for this research is presented in the following diagram:



3. FINDINGS AND DISCUSSION

3.1. Student Activities in STAD and PBL Model Learning

The STAD Learning Model emphasizes active learning activities for students. Dewi et al., (2021) revealed that STAD is one of several cooperative learning models that build active student activities in learning. Student activity in the STAD model in learning for three meetings is presented in the figure below:

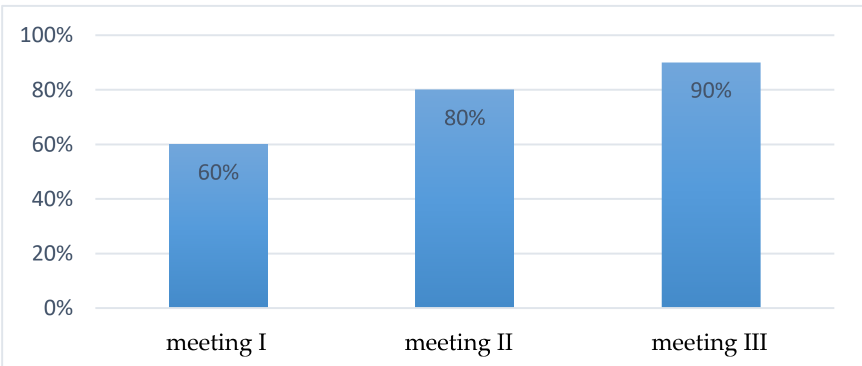


Figure 1. Percentage of student activity in the STAD model

The results of the analysis of student observation sheets showed that student activity in the STAD model learning showed an increase of 60% (early meeting), 80% (second meeting), and 90% (three meetings). Based on the activity category, the first and second meetings showed an active category, and the third meeting increased to very active. Thus, overall it can be said that student activity in STAD learning shows an active category. This is in line with study of Marsiniarif (2019) that STAD can improve student activity and quality of learning.

The PBL learning model also provides learning facilities that allow students to actively participate in learning (Ariandi, 2016). The analysis of student observation sheets showed that student activity in the PBL model learning also increased from meeting 1 to meeting 3. The active activity of students at the first meeting reached 60% (active category), 74% (active) in the second meeting, and 88% (very active) in the third meeting. This aligns with Jannah & Zuliana (2014) and Nasir (2016) research that student learning activities in problem-solving using PBL from the first meeting to the end continue to improve with good qualifications. The increase in student activity in the PBL model is presented in the following figure.

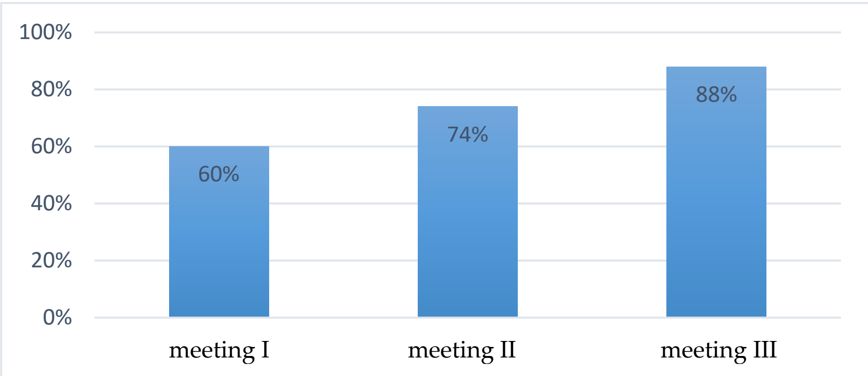


Figure 2. Percentage of student activity in the PBL model

Based on the results of student observations, it is known that the comparison of student activity in learning for the STAD and PBL models is presented in Table 3.

Table 3. Student Activities in STAD and PBL Model

Learning Model	Meeting			Average
	I	II	III	
STAD	60%	80%	90%	76,67%
PBL	60%	74%	88%	75,33%

Table 3 shows that the average percentage of student activity in the STAD learning model for class IXD is 76.67%. This percentage means that student activities in the STAD model are classified as active. The average percentage of student activity in the STAD PBL learning model for class IXA is 75.33%. This percentage also means that student activities in the PBL model are classified as active. Even though they both show activeness, if we look at the average activity of students in the two models, the average activity in STAD is slightly higher than in PBL. This is in line with Listiyowati & Sutaryono (2012) study that student activity is higher in classes that apply the STAD model than in PBL classes.

3.2 Mathematical Problem Solving Ability (MPSA)

The descriptive statistical analysis of students' MPSA test results in the STAD and PBL models is written in Table 4.

Table 4. Descriptive Analysis of MPSA

Descriptive	STAD	PBL
Mean	70,067	69,34
Variance	82,82	108,61
Standard Deviation	9,10	10,42
Minimum	52,86	55,71
Maximum	84,29	94,29

Based on descriptive statistical analysis, the mean MPSA in the STAD learning model is 70.067, and in the PBL model is 69.34. Based on the MPSA category, STAD is in a good category, and PBL is in a good category. This shows that the average MPSA in the STAD learning model is relatively slightly better than in the PBL model. Research by Listiyowati & Sutaryono (2012) and Ridayanti et al. (2014) also stated that the STAD learning model was better than PBL in students' MPSA.

MPSA categories and the number of students for each STAD and PBL model are presented in Table 5.

Table 5. Number of students and categories of MPSA

Score	STAD	PBL	Category
85 – 100	0%	7,7%	Very Good
70 – 84,99	60%	42,3%	Good
55 – 69,99	36%	50%	Enough
40 – 54,99	4%	0%	Less
0 – 39,99	0%	0%	Very Poor

Table 5 shows that most of the students' MPSA in STAD learning are in a good category (60%), others are in a good category (36%), and less (4%). While the MPSA of students in PBL, most of the students were in a good category (50%), others in the good category (42.3%), and very good (7.7%). Meanwhile, the average of each indicator is presented in Table 6.

Table 6. Average MPSA Indicator

No	Indicator	Class	
		STAD	PBL
1	Ability to identify problems	90	88,8
2	Ability to plan problem-solving	81,2	81,2
3	Ability to solve problems according to plan	60	58,7
4	Ability to interpret the solution	49,067	48,67
	Average	**70,067**	**69,34**

Table 6 shows that the indicators of the problem identification ability of students in the STAD class are better than in the PBL class, likewise on the ability to solve problems and interpret solutions. Meanwhile, the ability to plan to solve problems has the same average. This can be understood because this ability is the student's ability to determine the formula used in solving problems, where this ability is readily formed from the two models. After all, it applies relatively to the same active form. Thus, it can be concluded that the average ability of 3 of the 4 MPSA indicators in STAD learning is better than PBL, except that the indicators for planning problem solving are relatively the same.

Furthermore, a comparison test of the effectiveness of applying the STAD and PBL models in the MPSA will be carried out through inferential analysis. Inferential analysis was carried out with prerequisite tests (normality and homogeneity tests) and hypothesis testing. The normality test was carried out with the Kolmogorov-Smirnov statistic, with the calculation results shown in Table 7.

Table 7. Data Normality Test Results

Class	N	Statistics	Sig.	Description
STAD	25	0,734	0,654	Normal
PBL	26	0,699	0,713	Normal

Table 7 shows that both classes have sig values. > 0.05. This means that the two classes are normally distributed. Furthermore, the homogeneity test was carried out with the F test, and the calculation results are shown in Table 8.

Table 8. Results of Data Homogeneity Test

F_{count}	dk_1	dk_2	F_{table}	Description
1,31	25	24	2,257	Homogeneous

Based on Table 8 above, it is known that $F_{count} = 1.31 < 2.257 = F_{table}$, which means that the data variance of the two classes is homogeneous. Thus, due to the results of the prerequisite test, the data obtained are normally distributed, and the variance of the two data is homogeneous, so it is continued with hypothesis testing with an independent sample t-test. The results of hypothesis testing are presented in Table 9

Table 9. Hypothesis Testing Results

	t	df	Sig.
Posttest	0,240	49	0,811

Based on the hypothesis test, it is known that the value of sig. = 0.811 > 0.05 which means the hypothesis is rejected. Thus, there is no difference between the mean MPSA of class IX students of SMPN 1 Kolaka who study with the STAD learning model and the PBL model. The absence of this difference is because the STAD class and the PBL class emphasize student activities both individually and in groups that are active in developing student MPSA. Students' activeness in STAD and PBL learning can be the same because the same teacher and material. Suriyani (2019) stated that the STAD model affects students' MPSA because students have been able to follow and complete the learning steps well. Likewise, the PBL model gives positive results to MPSA because students are actively involved, get used to collaboration in groups, and respect each other's opinions between group members in solving mathematical problems (Rosmita, 2020). Based on the results of research and discussion, it was concluded that there was no difference in students' mathematical problem-solving abilities in using the STAD learning model or the PBL model.

4. CONCLUSION

The STAD learning model or the PBL model has no difference in students' mathematical problem-solving abilities. The absence of this difference is because both the STAD class and the PBL class emphasize the relatively equal activeness of students both individually and in groups. Therefore, teachers are expected to be able to apply the STAD model, PBL, or other learning models that are more appropriate for improving the MPSA. The selection of models and materials that match the characteristics of students needs to be done, considering that there are still several learning models that suppress learning activities in solving students' mathematical problems. So it is hoped that future studies can conduct research related to MPSA by using other learning models besides the STAD and PBL models, which may be more optimal for improving MPSA.

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