The Effectiveness of The Stad-Type Cooperative Learning Model on The Mathematical Problem-Solving Ability of Elementary School Students

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Abstract

Students’ ability to solve problems is still lacking because they often rely on memorizing concepts. The purpose of this research is to determine the effectiveness of the STAD-type cooperative learning model in helping students solve mathematical problems. This type of research used descriptive quantitative research. This research approach used an experiment with a Quasi experimental design in the form of a pre-test post-test control group design. This research was conducted using a sample of fifth-grade students at Dukuh Kerten State Elementary School, even semester of the 2022/2023 academic year. This research used a cluster random sampling technique where two experimental and control classes were obtained. Independent Sample T-Test is one type of data analysis test used. STAD and conventional learning models show different levels of effectiveness, as seen from the Sig. (2-tailed) of 0.044 < 0.05 indicate that H₀ is rejected. In the Independent sample t-test the mean value of the experimental class also bigger than the mean of the control class, which is 0.4280 > 0.2708. It showed that in improving fifth-grade students’ class V mathematics problem solving skills on geometric material, the STAD learning model is more effective to use.

Keywords: Mathematics; PISA; Problem Solving; STAD

1. Introduction

The main factor in human resource development is education, and through education it will improve its quality. Improving the quality of the education is an effort to contribute to the development of human resources. The community and the government must work together to create quality education. The central government then decided to involve local governments and the community in supervising education in schools in accordance with Law No. 20 of 2003 concerning the National Education System. Among the many subjects discussed today, one of the subjects that can contribute to improving the quality of education is mathematics.

According to Tampubolon & Sitompul (2022), mathematics is a skill that can help students thinking critically, reasoning, and communicating ideas. In learning, mathematics is classified as one of the subjects that is easy to understand, but often students have difficulty learning it. It is not uncommon for students to be asked to present their narrative in the form of stories, turn them into mathematical sentences, and solve narrative problems without clear instructions beforehand. Meanwhile, it can be seen that students' ability to solve problems is still lacking because they often rely on memorizing concepts.

According to Tambunan et al., (2020), problem solving is a process of familiarizing students with the way of thinking to overcome the types of cases that students will encounter in mathematical problems. In addition, problem solving is an effort to overcome a challenge to achieve a goal that does
not directly provide results. Problem solving has an important role, because solving all problems and in doing mathematics require problem-solving actions. Therefore, teachers are expected to be able to learn and provide their knowledge in mathematics learning so that students' mathematical problem-solving skills can improve (Hasyanah et al., 2023). There are four steps to solve the problem, according to Polya (1957), including understanding the problem, devising a plan, carrying out the plan, and looking back.

The facts prove that teaching mathematics to students is a challenge for many teachers in Indonesia. This occurs due to students' assessment that the learning strategies used by teachers are very boring because teachers mostly still apply conventional models, which during learning, students are placed in a passive position, and there is no opportunity for students to actively explore concepts that they do not understand, resulting in them not being able to understand the subject. Students' skills in solving problems can be influenced by the relationship between the teaching and learning methods used by teachers. The differences in students' academic grades and student activity can also be influenced by the interaction between teaching and learning strategies used in challenging classroom environments. The quality of learning applied by teachers also has a significant impact on the extent to which students participate in the teaching and learning process, where students demand a more dynamic classroom situation and are packaged through interesting mathematics learning activities (Pradnya, 2021). Teachers have a great obligation to be able to direct students to learn in an effective way, where students also really need teachers who are competent in their fields, and who are able to use exciting teaching strategies so that students are not easily bored. Although there is a lot of evidence that teaching using the recommended teaching method is the best way to improve student achievement, it turns out that not a few teachers still implement the old method and make the learning atmosphere less effective. Active teachers tend to teach what they believe, even if this is contrary to what the current curriculum says where students should be more involved in learning rather than passively accepting what the teacher says (Saleh & Filawati, 2019).

Indonesian students still have below-average abilities in math, reading, and science. The mathematical proficiency of Indonesian students is ranked 63rd out of 69 countries according to PISA 2015 released by the OECD with an average of 386 in mathematics. The average obtained by Indonesia is far below the OECD average, which is 490. The low mathematical ability of students can be seen from the results of the 2018 PISA survey released by the OECD simultaneously on December 3, 2019, showing that out of 79 countries, Indonesian students are ranked 73rd. In 2018, Indonesia's mathematics proficiency score decreased with a score of 379 points, which was 110 points lower than the OECD average score. So, the survey results show that students' mathematical skills must be improved again because in 2018 the mathematics score decreased from 2015 (Bakrun et al., 2019).

At Dukuh Kerten State Elementary School, the observation results showed that students lacked mathematical problem-solving skills. It can be said that it is lacking because students have not succeeded in meeting the indications of problem solving. According to Polya (1957), problem-solving indicators are digesting problems, creating problem solutions, working on solutions, and re-explaining the solutions used. To have strong problem-solving skills, students must demonstrate certain problem-solving indicators. In line with Devarosary et al. (2020) research, students often face the following problems when trying to solve math problems: (1) Some students think that the sample problems and problems given by the teacher are different, (2) Students usually follow the same way of solving problems as the teacher and are afraid to try because they are afraid of failing, (3) Students are afraid to try new things with their abilities, (4) Students lack understanding of the core principles of the problem, (5) Students find it difficult to develop their own ideas, (6) Students work on problems with little care, and (7) When doing work, students only write down the answers without using questions and methods. Consequently, it can be seen from the problems and indicators of problem solving, different learning strategies are needed for students to solve mathematical problems. Learning through a cooperative learning model thus inspires students to express their views with more confidence and respect the views of others to achieve their goals.

Novianti et al., (2020) demonstrated that innovative and engaging learning models are needed to familiarize students with the challenges of mathematical problem-solving to aid their development. Agustina (2016), also showed that giving students the opportunity to communicate their thoughts in their own language and method can help them improve their problem-solving skills. According to Nurhikmah & Emawati (2020), one of the alternatives that can be used is cooperative learning model, where cooperative learning requires students to discuss in groups actively and positively and still respect
the ideas put forward by their group friends. Cooperative learning models have various types, one of which is the cooperative learning model of the Student Teams Achievement Division (STAD).

Learning models such as STAD or Student Team Achievement Division is assumed to be able to help the development of students' mathematical problem-solving skills. According to Rizzaludin (2022), this cooperative learning activity called STAD in its implementation involves 4 to 5 students with different achievements, ethnicities, and genders collected in a study group, where the educator's task is to present the material first. After the teacher presents the material, the students with each group then work to ensure that all members have knowledge of the material. Asmedy (2021), argued that the STAD learning model is a learning model that divides students into a number of heterogeneous groups in which it contains 4 to 5 individuals, each of whom comes from a different ethnic background, academic skills, and gender. Through a number of these descriptions, it can be concluded that cooperative learning with the STAD model is a learning model where educators present material to a group consisting of between 4 to 5 mixed individuals in order to be able to work together, and ensure that each group member is proficient in the material.

The steps in the implementation of the STAD learning model according to Rianty & Pratiwi (2018), are: (1) to start learning, the teacher divides students into several groups where one group contains 4-5 people, (2) the educator explains the subject matter, (3) each group gets an assignment from the teacher that must be completed by his group and students who are familiar with the material can explain it to their friends in one group until everyone knows it, (4) the teacher gives questions to all students, (5) students are instructed by the teacher to collect the results of group work, (6) students are asked to give a presentation by the teacher; and (7) the winning group is announced.

Based on previous research, it is confirmed that the STAD learning model is able to help students improve their mathematical problem-solving skills, which can be known from the academic results. According to Asmedy (2021), the STAD learning model has a considerable impact on the learning outcomes obtained. Through research by Saleh & Filawati (2019), it can be known that the implementation of the STAD model cooperative learning strategy is able to help students improve their activities and academic achievement at school. Based on the research of Tambunan et al., (2020), with STAD learning, students' ability to handle students' math problems can be improved. So that by applying the STAD learning model, teachers can create fun learning with group discussions where the learning activities prioritize interaction between students. Interaction between students in learning groups can be a means of having peer tutors, where students can help each other in understanding the subject matter. Hence, students can easily solve a given problem.

Considering the problems above and the explanation of the STAD type cooperative learning model, the researcher will apply the STAD-type cooperative learning in this study. Researchers want to find out how the effectiveness of the STAD-type cooperative learning model can help students to solve mathematical problems well. In addition, the cooperative approach of the STAD model in fifth grade mathematics subjects at Dukuhan Kerten State Elementary School, Laweyan, Surakarta for the 2022/2023 academic year is expected to be able to increase the level of students' skills in solving mathematical problems through discussion.

2. Method

This is a quantitative research using the Quasi Experimental Method which is a research technique with a sample of two classes to determine the impact of certain treatments. Pre-test Post-test Control Group Design is a form of research design that is included in one of the methods in the research methodology used. This research was carried out at Dukuhan Kerten State Elementary School for the 2022/2023 academic year which is located at Jl. A. Yani No. 24, Kerten, Laweyan, Surakarta, Central Java.

The population of this study is all students of Dukuhan Kerten State Elementary School which is 219 students. Then, the researcher used the cluster random sampling technique obtained two sample classes for the study. The sample classes used in the study were the A class with 25 students as the control class and the B class with 25 students as the experimental class. The instruments used in this study are pre-test and post-test questions, containing 5 validated description questions designed to measure students' ability to solve mathematical problems.

The procedure used by the researcher in this study is the preparation, implementation, and processing of data and ends with drawing conclusions. The data analysis used in this study is descriptive analysis and inferential tests including homogeneity tests and normality tests. After that, the n-gain
value is calculated from the results of the work of pre-test and post-test students. Then, by using SPSS 23, the independent sample T-test was continued to see the final result. To find the n-gain value, researcher used the formula: (PLEASE TRANSLATE THE FORMULA TO ENG)

\[ N - \text{gain} = \frac{\text{posttest score} - \text{pretest score}}{\text{max score} - \text{pretest score}} \]

After finding the N-Gain value, researcher continued the normality test of the N-Gain value, then continued the Independent Sample T-Test test and group according to the criteria below:

### Table 1. N-Gain Effectiveness Benchmark

<table>
<thead>
<tr>
<th>Percentage (%)</th>
<th>Benchmark</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 40</td>
<td>Ineffective</td>
</tr>
<tr>
<td>40 - 50</td>
<td>Less Effective</td>
</tr>
<tr>
<td>55 - 75</td>
<td>Quite Effective</td>
</tr>
<tr>
<td>&gt; 76</td>
<td>Effective</td>
</tr>
</tbody>
</table>

**Source:** Rahma, (2021)

For more details about the research steps presented in the form of a research flow diagram as follows:

3. Results and Discussions

The data were obtained to evaluate and characterize the effectiveness of the STAD learning strategy with group discussion techniques as shown in the analysis below, to test the problem-solving ability of primary school students:

**Descriptive Analysis**

The results of the pre and post test descriptive analysis in both classes are as follows:

### Table 2. Descriptive Analysis of Mathematical Problem Solving Ability

<table>
<thead>
<tr>
<th></th>
<th>Experiment’s Pre-test</th>
<th>Experiment’s Post-test</th>
<th>Control’s Pre-test</th>
<th>Control’s Post-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Value</td>
<td>70</td>
<td>100</td>
<td>66</td>
<td>82</td>
</tr>
</tbody>
</table>
Minimum Values | 27 | 30 | 10 | 19
Mean | 50.04 | 71.00 | 42.64 | 58.56
Median | 51.00 | 72.00 | 47.00 | 62.00
Modus | 47 | 30 | .47 | 65

Based on table 2, descriptive analysis was obtained by the average of the experimental class before being given the STAD learning model treatment, which was 50.04. After being given the STAD learning strategy treatment, the average score was 71.00. The average learning outcome of the control class was 42.64 before being given the conventional learning model treatment. After being treated with the conventional learning model, an average score of 58.56 was obtained.

**Normality Test**

The method used to test normality is the Lilliefors method with a significance level of 5%. Data is considered as normally distributed if the significance > 5%. When the data is normally distributed, parametric statistics can be used to check it, but if the data is not normally distributed, non-parametric statistics can be used to check it. The results of the normality test conducted using SPSS include:

<table>
<thead>
<tr>
<th>Class</th>
<th>Kolmogrov-Smirnov</th>
<th>Shapiro-Wilk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning Outcomes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experimental Class PreTest (STAD)</td>
<td>.209</td>
<td>25</td>
</tr>
<tr>
<td>Control Class PreTest (Conventional)</td>
<td>.137</td>
<td></td>
</tr>
</tbody>
</table>

The significance of the experimental class is < 0.05 which is 0.032 as seen in table 3 above which shows that the data is not distributed normally. A significance of 0.347 was obtained for the control class which indicates that the data is normally distributed because the significance > 0.05.

<table>
<thead>
<tr>
<th>Class</th>
<th>Kolmogrov-Smirnov</th>
<th>Shapiro-Wilk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning Outcomes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PostTest Experimental Class (STAD)</td>
<td>.122</td>
<td>25</td>
</tr>
<tr>
<td>PostTest Control Class (Conventional)</td>
<td>.180</td>
<td></td>
</tr>
</tbody>
</table>

The significance of the experimental class is > 0.05, which is 0.240 as seen in Table 4, above which shows normal distributed data. The significance for the control class was 0.006 which indicates that the data is not distributed normally because the significance < 0.05.

**Homogeneity Test**

The next test is the homogeneity test. The purpose of this analysis is to determine whether the current population includes people with the same level of variation (Iyasa & Hapsari, 2020). The data can be assumed to be homogeneous if the significance value > 0.05. On the other hand, if the significance < 0.05 can be concluded that the data is not homogeneous. Below are the results of data homogeneity pre-test and post-test:

<table>
<thead>
<tr>
<th>Class</th>
<th>Levene Statistic</th>
<th>df1</th>
<th>df2</th>
<th>Say.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning Outcomes</td>
<td>Based on Mean</td>
<td>2.755</td>
<td>3</td>
<td>96</td>
</tr>
<tr>
<td>Based on Median</td>
<td>2.317</td>
<td>3</td>
<td>96</td>
<td>.080</td>
</tr>
<tr>
<td>Based on Median and with adjusted df</td>
<td>2.317</td>
<td>3</td>
<td>83.271</td>
<td>.082</td>
</tr>
</tbody>
</table>
The pre-test and post-test homogeneity tests can be seen in Table 5. It can be concluded that the data are not homogeneous. It can be seen that the significance in the based on mean part is 0.047 which means < 0.05.

### N-Gain Test

The N-Gain test is a test to determine the effect of increasing the effectiveness of the learning model between the experimental class and the control class followed by pre-test and post-test analysis using the N-gain equation below:

\[ N \text{-} \text{gain} = \frac{\text{posttest score} - \text{pretest score}}{\text{ideal score} - \text{pretest score}} \]

The improvement of students’ ability to solve mathematical problems before and after being treated with different learning models was determined through N-Gain analysis. After analyzing with the N-gain equation and obtaining the N-gain score, the first step of the normality test using the N-gain score is as follows:

#### Table 6. Results of the N-gain Score Normality Test

<table>
<thead>
<tr>
<th>Class</th>
<th>Kolmogrov-Smirnov</th>
<th>Shapiro-Wilk</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Statistic.</td>
<td>df</td>
</tr>
<tr>
<td>N-Gain Score</td>
<td>Experimental Class (STAD)</td>
<td>.153</td>
</tr>
<tr>
<td></td>
<td>Control Class (Conventional)</td>
<td>.187</td>
</tr>
</tbody>
</table>

As explained in Table 6, N-gain test normality score shows that the experimental class is normally distributed with a significance of 0.087 which means > 0.05 and the control class is also normally distributed with a significance of > 0.05 which is 0.071. Independent Sample T-Test will be used to continue the normality test because of the findings of the N-gain states that the experimental class as well as the control are normally distributed. Independent Sample T-Test to obtain information on whether the STAD learning model is effective in helping to develop students' mathematical problem-solving skills by comparing the results of pre-test post-test between the experimental and control classes (Amarofah et al., 2022).

#### Table 7. Independent Sample T-Test (Group Statistics)

<table>
<thead>
<tr>
<th>Class</th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Std. Error Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>N-Gain Score</td>
<td>Experimental Classes</td>
<td>25</td>
<td>.4280</td>
<td>.31382</td>
</tr>
<tr>
<td></td>
<td>Control Classes</td>
<td>25</td>
<td>.2708</td>
<td>.21440</td>
</tr>
</tbody>
</table>

Table 7 shows the results of the independent sample t-test. The mean value of the N-gain of the experimental class is 0.4280 and if the percentage is in accordance with the N-gain effectiveness criterion, it is 42.8%. The mean N-gain of the control class is 0.2708 and if percentaged, it is 27.08%. The mean N-gain value serves to determine the level of effectiveness between the experimental and control classes.

The mean N-gain value obtained by the experimental and control classes is adjusted to table 1. Where the experimental class showed that the application of the STAD learning model was less effective in helping to improve mathematical problem-solving skills. Meanwhile, the mean N-gain value of the control class shows that the conventional learning model is not effective in helping to improve mathematical problem-solving skills. Therefore, quantitatively descriptively, it can be said that there is a difference in the effectiveness of the application of the STAD and conventional learning models in helping to develop students' abilities in solving mathematical problems.

#### Table 8. Independent Sample T-Test Results

<table>
<thead>
<tr>
<th></th>
<th>Lavene’s Test for Equality of Variances</th>
<th>t-test for Equality of Means</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The significance value in table 8 of Levene's Column Test for the variance equation is 0.038 < 0.05 which indicates if the variance data N-Gain Experimental classes as well as controls are not homogeneous. Test results of independent sample t-test can be seen on the Sig. (2-tailed) section equal variances assumed. Sig. (2-tailed) has been obtained which is 0.044 which means < 0.05 as determined by the test table independent sample t-test in table 8. Thus, conclusions can be drawn if rejected the STAD learning model and H₀ conventional significantly different in its effectiveness in increasing the level of mathematical problem-solving ability of fifth-grade students of Dukuhan Kerten State Elementary School. According to Sinambela (2017), learning can be said to be effective if it meets the indicators of effectiveness, namely: (1) mastery of learning, (2) the amount of time used by students optimally in each lesson, (3) the feasibility of the educator's ability in the continuity of learning, and (4) learning activities are given a positive response by students.

This is in accordance with the findings of Tambunan et al., (2020), showing that using the STAD learning model is effective in improving students' mathematical problem-solving skills. According to Nuralam & Khalidah (2019), the STAD-type problem-based learning strategy is effectively applied in terms of process and results in improving students' mathematical problem-solving skills. Dewi et al., (2019), also concluded that the STAD learning model supported by learning media turned out to be superior to the conventional learning model. Syarifuddin (2020) obtained the result that learning using the learning model learning cycle effectively applied in grade eight of SMP Negeri 3 Salomekko. Other research by Harahap (2017), found that STAD-type cooperative learning is more effectively applied in mathematics learning.

Table 2, the descriptive analysis table of mathematical problem-solving ability, shows that when compared with the control class, which applies conventional strategies, the experimental class using the STAD model achieves a higher and superior mean. It showed that the STAD learning model offers a more efficient way for students to improve their skills in solving math problems. This is in accordance with the conclusion of Kristin (2016), which found that classes that use the STAD model outperform the control classes in terms of average. In addition, Harahap's research (2017), also concluded that the average generated by the STAD learning model was higher than that of the expository method learning model. This is also in accordance with the findings of Irwanti & Widodo (2018), which concludes that the STAD learning model class produces superior mathematics academic scores to conventional learning model classes.

When compared to the use of conventional models in learning, the STAD model is superior in results. This is because in STAD learning, students are asked to actively participate in their learning and work on each math problem in groups with critical thinking. The students' thinking process is utilized in group discussions, opinions, evaluations, and presentations of work results during the learning process of the STAD model. Teachers closely supervise during learning to ensure students do not experience difficulties, unlike the application of conventional learning, which is only focused on the teacher and puts students in a passive role, where there is no opportunity for students to actively explore concepts that they do not understand, resulting in them not being able to understand the subject matter and the learning outcomes are not optimal.

The research on the data and interpretation of the findings of the study produced various conclusions, which are as follows: 1) The experimental class that applied the STAD learning model with the group discussion method had a considerable difference in problem-solving ability with an average result of 42.80 and the control class with the conventional learning model had an average result of 27.08, 2) The STAD learning model using the group discussion method was more effectively used to improve students' mathematical problem-solving skills.

4. Conclusion

Based on the findings of this study, it can be concluded that the STAD and conventional learning models have different influences on mathematical problem-solving ability. The average STAD class is larger than that of conventional classes, which shows that the STAD learning model is more effective.
in helping students improve their mathematical problem-solving skills. This is because the STAD model has met the effectiveness indicators, namely learning mastery, the amount of time used by students optimally in each learning activity, the feasibility of educators' abilities in the continuity of learning, and the positive response of students in learning activities.

Bibliography


