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# The Effect of the Student Teams Achievement Divisions (STAD) Cooperative Learning Model Assisted by Student Worksheets on the Mathematics Learning Outcomes

Sintiya Fransisca Br Tarigan*, Regina Sipayung, Patri Janson Silaban, Darinda Sofia Tanjung, Jhonas Dongoran

[1]Department of Primary School Teacher Education, Universitas Katolik Santo Thomas, Indonesia

*Corresponding author's email: fran80918@gmail.com

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**ABSTRACT**

Mathematics learning in elementary schools is often dominated by teacher-centered instruction, resulting in limited student participation and low learning outcomes, particularly in the topic of plane geometry. This study aimed to examine the effect of the Student Teams Achievement Divisions (STAD) cooperative learning model assisted by Student Worksheets (LKPD) on the mathematics learning outcomes of third-grade students at SD Negeri 060973 Medan during the 2025/2026 academic year. This research employed a quantitative approach using a pre-experimental one-group pretest–posttest design. The sample consisted of 28 students selected through total sampling. Data were collected using a mathematics achievement test and a student response questionnaire. Before implementation, both instruments were validated through expert judgment and empirical testing. Item validity was determined using the Pearson Product-Moment correlation by comparing the calculated correlation coefficients with the critical *r*-value at the 5% significance level, while reliability was assessed using Cronbach's Alpha, with coefficients exceeding 0.70, indicating high reliability. Data were analyzed using descriptive statistics, normality testing, Pearson correlation, the coefficient of determination, and the *t*-test with IBM SPSS Statistics Version 25. The findings showed that the mean score increased from 52.89 on the pretest to 80.71 on the posttest. The correlation coefficient was 0.804, the coefficient of determination reached 64.64%, and hypothesis testing confirmed a significant positive effect ($t = 2.713$, $p = 0.012$). Therefore, the STAD cooperative learning model assisted by Student Worksheets effectively improves elementary students' mathematics learning outcomes.

## Introduction

Education plays a fundamental role in developing students' potential in terms of knowledge, skills, and attitudes. The quality of education is largely determined by the effectiveness of the learning process implemented in the classroom. At the elementary school level, Mathematics is a fundamental subject that contributes significantly to the development of logical reasoning, critical thinking, systematic thinking, and problem-solving skills. These competencies are essential for students to face academic challenges and everyday situations. However, despite the emphasis on student-centered learning in the current curriculum, mathematics instruction in many elementary schools remains

predominantly teacher-centered, limiting students' opportunities to actively construct knowledge through meaningful learning experiences. Consequently, students often become passive learners, resulting in low conceptual understanding and unsatisfactory learning outcomes.

Preliminary observations conducted at SD Negeri 060973 Medan revealed several instructional problems in Grade III mathematics classes. Classroom instruction was still dominated by conventional lecture-based methods, students' participation in classroom discussions remained low, and most students experienced difficulties in understanding mathematical concepts, particularly those related to plane geometry. Geometry learning requires students to recognize shapes, understand spatial relationships, compare attributes, and apply geometric concepts in solving contextual problems. These competencies are difficult to develop through memorization alone and require active exploration and discussion. Examination results showed that among 30 students, 13 students (43.33%) were categorized as *Needs Improvement*, 7 students (23.33%) as *Fairly Developed*, 4 students (13.33%) as *Developed*, and only 6 students (20.00%) reached the *Highly Developed* category. These findings indicate that most students had not yet achieved the expected learning outcomes, highlighting the need for a learning approach that actively engages students in constructing mathematical concepts.

Recent studies have consistently demonstrated that cooperative learning is an effective instructional strategy for improving students' academic performance. Among various cooperative learning models, the Student Teams Achievement Divisions (STAD) model has received considerable attention because it encourages students to learn collaboratively through heterogeneous group discussions, peer tutoring, and shared responsibility for learning. According to Slavin's cooperative learning theory, students achieve better learning outcomes when they work together to accomplish common academic goals while being individually accountable for their performance. Within STAD, higher-achieving students explain concepts to their peers, while lower-achieving students receive immediate support from classmates. This interaction promotes elaboration, clarification, and cognitive conflict, all of which facilitate deeper conceptual understanding. In mathematics learning, particularly geometry, explaining ideas, comparing different solution strategies, and discussing geometric properties enable students to refine their understanding and correct misconceptions more effectively than passive listening.

The effectiveness of STAD is further strengthened when combined with Student Worksheets (LKPD). Student Worksheets serve not merely as instructional media but as structured learning scaffolds that guide students through sequential learning activities. According to Dachi et al. (2021), LKPD facilitates active learning by organizing problem-solving activities, encouraging students to observe patterns, analyze mathematical relationships, and formulate conclusions independently. In geometry learning, LKPD provides systematic exercises that require students to identify characteristics of geometric figures, classify shapes, compare similarities and differences, and solve contextual problems collaboratively. This structured guidance helps students gradually develop conceptual understanding while supporting collaborative discussions within their learning groups. Consequently, LKPD complements the cooperative nature of STAD by ensuring that group interactions remain focused on meaningful mathematical reasoning rather than simple answer sharing.

The integration of STAD and LKPD also promotes several important learning processes that explain improvements in students' mathematics achievement. First, peer interaction enables students to exchange ideas, ask questions, and receive immediate feedback from classmates, thereby strengthening conceptual understanding through social learning.

Second, collaborative reasoning encourages students to justify mathematical solutions, compare alternative strategies, and evaluate the correctness of different approaches. Third, guided problem-solving through LKPD reduces students' cognitive difficulties by presenting learning tasks in logical and manageable steps, allowing them to connect prior knowledge with new mathematical concepts. Finally, individual accountability, which is a core component of STAD, motivates every student to actively participate because each member contributes to the group's overall achievement. Together, these learning processes create a student-centered learning environment that facilitates meaningful mathematical understanding rather than rote memorization.

Previous empirical studies support the effectiveness of both STAD and Student Worksheets in improving learning outcomes. Hermawan (2025) reported that STAD significantly increased students' participation and mathematics achievement through collaborative learning and peer interaction. Likewise, Dachi et al. (2021) found that Student Worksheets improved conceptual understanding by providing structured learning activities that guided students through problem-solving processes. Other studies have similarly demonstrated that cooperative learning enhances communication skills, learning motivation, and academic achievement because students actively discuss concepts, exchange ideas, and construct knowledge collaboratively. The expected findings of the present study are therefore consistent with previous research because both cooperative interaction and structured instructional guidance facilitate meaningful learning. However, differences in the magnitude of learning improvement may occur because learning outcomes are influenced by classroom characteristics, students' prior mathematical ability, instructional implementation, and the quality of learning materials. Therefore, investigating the integrated implementation of STAD assisted by Student Worksheets provides additional empirical evidence regarding how these instructional components work together to improve mathematics learning.

Although numerous studies have investigated the effectiveness of either the Student Teams Achievement Divisions (STAD) cooperative learning model or Student Worksheets independently, relatively few studies have integrated these two instructional components into a comprehensive learning strategy, particularly in elementary mathematics education. Previous studies generally focused on evaluating the effectiveness of STAD without fully utilizing Student Worksheets as structured instructional media capable of guiding students throughout cooperative learning activities. Likewise, studies examining Student Worksheets often emphasized their role as learning media without combining them with a well-established cooperative learning model. Consequently, empirical evidence regarding the integrated implementation of the Student Teams Achievement Divisions (STAD) cooperative learning model assisted by Student Worksheets remains limited, especially among Grade III elementary school students.

This limitation represents the research gap addressed in the present study. The novelty of this research lies in integrating the Student Teams Achievement Divisions (STAD) cooperative learning model with Student Worksheets to establish a more structured, interactive, collaborative, and student-centered mathematics learning environment. Unlike previous studies that examined these instructional components separately, this study combines cooperative group learning with structured worksheets to facilitate active participation, conceptual understanding, peer interaction, collaborative reasoning, and problem-solving simultaneously. This integrated instructional strategy is expected to produce more meaningful learning experiences while improving students' mathematics learning outcomes.

Based on the identified research gap, the present study aims to analyze the effect of the Student Teams Achievement Divisions (STAD) cooperative learning model assisted by Student Worksheets on the mathematics learning outcomes of Grade III students at SD Negeri 060973 Medan during the 2025/2026 academic year. The research hypothesizes that the implementation of the Student Teams Achievement Divisions (STAD) cooperative learning model assisted by Student Worksheets has a positive and significant effect on students' mathematics learning outcomes. The findings are expected to contribute both theoretically and practically by enriching the literature on cooperative learning in elementary mathematics education and providing teachers with an effective instructional alternative for improving mathematics achievement. Furthermore, this study contributes to a better understanding of how collaborative learning supported by structured instructional media promotes conceptual understanding, active participation, and sustainable improvement in elementary mathematics learning.

## Research Method

### *Research Design*

This study employed a quantitative approach using a pre-experimental research design to examine the effect of the Student Teams Achievement Divisions (STAD) cooperative learning model assisted by Student Worksheets on the mathematics learning outcomes of third-grade elementary school students. A quantitative approach was selected because it enables the measurement of changes in students' learning outcomes through statistical analysis. The study adopted a One-Group Pretest–Posttest Design, in which a single experimental group was administered a pretest ($O_1$) before receiving the instructional treatment (X) and a posttest ($O_2$) after the treatment. The difference between the pretest and posttest scores was used to determine the effectiveness of the instructional model.

**Table 1.** One-Group Pretest–Posttest Design

| Pretest | Treatment | Posttest |
|---|---|---|
| $O_1$ | X | $O_2$ |

Note:
$O_1$ = Pretest;
X = Learning using the Student Teams Achievement Divisions (STAD) cooperative learning model assisted by Student Worksheets;
$O_2$ = Posttest.

### *Research Setting*

The research was conducted at SD Negeri 060973 Medan, Indonesia, during the second semester of the 2025/2026 academic year. The school was selected based on preliminary observations indicating that students' mathematics learning outcomes were relatively low and that the STAD cooperative learning model assisted by Student Worksheets had not previously been implemented in mathematics instruction. The study was carried out from January to July 2026, including the preparation of research instruments, instrument validation, implementation of the learning intervention, data collection, statistical analysis, and report writing.

### *Research Participants*

The population consisted of all third-grade students of SD Negeri 060973 Medan during the 2025/2026 academic year. Since the population comprised only 28 students, the study employed the total sampling technique (saturated sampling), whereby all members of the population were included as research participants. Thus, the sample consisted of 28 third-grade students, all of whom received the instructional treatment throughout the research period.

***Research Instruments***

Data were collected using four research instruments.

1. Mathematics Learning Achievement Test, consisting of multiple-choice questions administered as both the pretest and posttest to measure students' learning outcomes on the topic of plane geometry.
2. Questionnaire, designed using a five-point Likert scale to obtain students' responses toward the implementation of the STAD cooperative learning model assisted by Student Worksheets.
3. Observation Sheet, used to monitor the implementation and fidelity of the learning process during the instructional intervention.
4. Documentation, including students' attendance records, learning achievement data, lesson implementation records, and photographs documenting classroom activities throughout the study.

***Data Collection Procedures***

The research was conducted through several sequential stages. Initially, students completed a pretest to assess their prior knowledge of mathematics before the intervention. Subsequently, the instructional treatment was implemented using the Student Teams Achievement Divisions (STAD) cooperative learning model assisted by Student Worksheets. During the learning process, classroom observations were conducted to evaluate the implementation of the instructional activities. Upon completion of the intervention, students completed a posttest to measure their learning achievement after receiving the treatment. Finally, students responded to a questionnaire regarding their learning experiences, while supporting documentation was collected to strengthen the research findings.

***Instrument Validity and Reliability***

Prior to data collection, all research instruments underwent validity and reliability testing to ensure their quality. Item validity was examined using the Pearson Product–Moment correlation coefficient, whereas instrument reliability was evaluated using Cronbach's Alpha with the assistance of IBM SPSS Statistics Version 25. The results indicated that all retained test items and questionnaire statements met the required validity criteria and demonstrated high reliability coefficients. Therefore, the instruments were considered valid, reliable, and appropriate for collecting research data.

***Data Analysis***

The collected data were analyzed using IBM SPSS Statistics Version 25 through both descriptive and inferential statistical techniques.

Descriptive statistics were employed to summarize students' learning outcomes by calculating the mean, standard deviation, standard error, frequency distribution, and percentages.

Inferential statistical analyses included:

1. Shapiro–Wilk Normality Test to determine whether the research data were normally distributed.
2. Pearson Product–Moment Correlation Analysis to examine the relationship between the implementation of the STAD cooperative learning model assisted by Student Worksheets and students' mathematics learning outcomes.
3. Coefficient of Determination ($R^2$) to identify the magnitude of the instructional model's contribution to students' learning outcomes.
4. Paired Sample t-test to determine whether there was a statistically significant difference between students' pretest and posttest scores after the instructional treatment. The null hypothesis ($H_0$) was rejected if the significance value (p) was less than 0.05.

5. Normalized Gain (N-Gain) Analysis to measure the level of improvement in students' mathematics learning outcomes following the implementation of the Student Teams Achievement Divisions (STAD) cooperative learning model assisted by Student Worksheets. The N-Gain scores were interpreted according to standard effectiveness categories (high, moderate, and low improvement).

Overall, these analytical procedures were employed to determine the effectiveness of the STAD cooperative learning model assisted by Student Worksheets in improving third-grade students' mathematics learning outcomes at SD Negeri 060973 Medan.

## Findings

### *Pretest Results*

Before the implementation of the Student Teams Achievement Divisions (STAD) cooperative learning model assisted by Student Worksheets, students were administered a pretest to assess their initial mathematics achievement on the topic of Plane Geometry. The pretest was conducted to determine students' prior knowledge before the instructional intervention. The obtained scores were analyzed descriptively by calculating the mean, standard deviation, and standard error to provide an overview of students' initial learning achievement.

**Table 2.** Frequency Distribution of Pretest Scores

| Score (X) | Frequency (f) | fX | $X - \bar{x}$ | $(X - \bar{x})^2$ | $f(X - \bar{x})^2$ |
|---|---|---|---|---|---|
| 29 | 1 | 29 | -23.89 | 570.869 | 570.869 |
| 32 | 1 | 32 | -20.89 | 436.511 | 436.511 |
| 36 | 2 | 72 | -16.89 | 285.369 | 570.737 |
| 39 | 2 | 78 | -13.89 | 193.011 | 386.023 |
| 43 | 4 | 172 | -9.89 | 97.869 | 391.471 |
| 50 | 3 | 150 | -2.89 | 8.369 | 25.106 |
| 54 | 2 | 108 | 1.11 | 1.226 | 2.452 |
| 57 | 3 | 171 | 4.11 | 16.869 | 50.606 |
| 61 | 4 | 244 | 8.11 | 65.726 | 262.903 |
| 64 | 2 | 128 | 11.11 | 123.369 | 246.737 |
| 68 | 2 | 136 | 15.11 | 228.226 | 456.452 |
| 75 | 1 | 75 | 22.11 | 488.726 | 488.726 |
| 86 | 1 | 86 | 33.11 | 1,096.272 | 1,096.272 |
| Total | 28 | 1,481 | | | 8,984.865 |

The descriptive statistical analysis of the pretest scores for the 28 students revealed a mean score of 52.89. This average score was below the school's Minimum Learning Achievement Criterion (MLAC), indicating that most students had not yet achieved the expected level of mastery in the Plane Geometry topic. These findings suggest that students experienced difficulties in understanding fundamental geometric concepts prior to the instructional intervention.

The standard deviation of 17.91 indicates that students' initial mathematics achievement varied considerably. This variation is reflected in the wide range of scores, from the lowest score of 29 to the highest score of 86, suggesting substantial differences in students' prior knowledge and academic abilities. Consequently, an instructional strategy capable of accommodating diverse learning abilities was required.

Furthermore, the standard error of 3.45 demonstrates that the sample mean provides a reasonably accurate estimate of the population mean. A relatively small standard error

indicates that the sample average is sufficiently representative of the students' overall initial mathematics achievement.

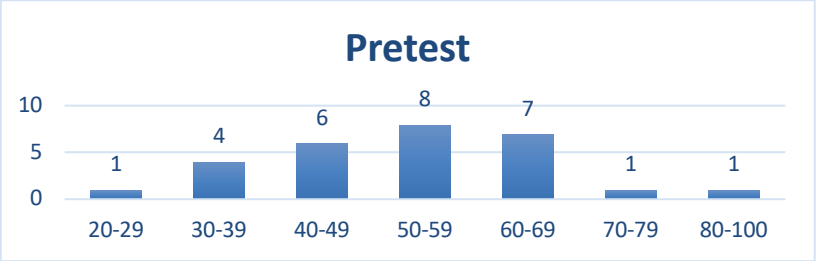


**Figure 1.** Frequency Distribution of Pretest Scores

The distribution of pretest scores by class interval shows that 1 student (3.57%) scored within the 20–29 interval, 4 students (14.29%) scored within 30–39, 6 students (21.43%) scored within 40–49, 8 students (28.57%) scored within 50–59, 7 students (25.00%) scored within 60–69, 1 student (3.57%) scored within 70–79, and 1 student (3.57%) achieved a score within the 80–100 interval. Most students obtained scores ranging from 50 to 69, indicating that their initial mathematics achievement was generally at a low to moderate level.

Overall, the pretest findings demonstrate that students' initial understanding of Plane Geometry was not yet satisfactory. Therefore, the implementation of the Student Teams Achievement Divisions (STAD) cooperative learning model assisted by Student Worksheets was considered an appropriate instructional alternative to enhance students' mathematics learning outcomes by promoting active participation, collaborative learning, and deeper conceptual understanding.

***Posttest Results***

Following the completion of the learning process using the Student Teams Achievement Divisions (STAD) cooperative learning model assisted by Student Worksheets, students were administered a posttest to assess their mathematics achievement on the topic of Plane Geometry after receiving the instructional treatment. The posttest results were analyzed descriptively by calculating the mean, standard deviation, and standard error to evaluate students' learning achievement after the intervention.

**Table 3.** Frequency Distribution of Posttest Scores

| Score (X) | Frequency (f) | fX | $X - \bar{x}$ | $(X - \bar{x})^2$ | $f(X - \bar{x})^2$ |
|---|---|---|---|---|---|
| 65 | 3 | 195 | -15.71 | 246.80 | 740.40 |
| 75 | 11 | 825 | -5.71 | 32.60 | 358.60 |
| 85 | 9 | 765 | 4.29 | 18.40 | 165.60 |
| 95 | 5 | 475 | 14.29 | 204.20 | 1,021.00 |
| Total | 28 | 2,260 | | | 2,285.60 |

The descriptive statistical analysis of the posttest scores for the 28 students revealed a mean score of 80.71, indicating that students' mathematics achievement after participating in the Student Teams Achievement Divisions (STAD) cooperative learning model assisted by Student Worksheets exceeded the school's Minimum Learning Achievement Criterion (MLAC). This result demonstrates a substantial improvement in students' understanding of the Plane Geometry topic following the instructional intervention.

The standard deviation of 9.02 indicates a relatively small variation in students' posttest scores, suggesting that students' achievement became more homogeneous after the learning intervention. Compared with the pretest results, the distribution of scores became more consistent, with scores ranging from 65 to 95, indicating that most students achieved satisfactory learning outcomes.

Furthermore, the standard error of 1.74 demonstrates that the posttest mean provides a highly reliable estimate of the population mean. The smaller standard error compared with that of the pretest suggests that students' learning achievement after the intervention was more stable and representative of the overall class performance.

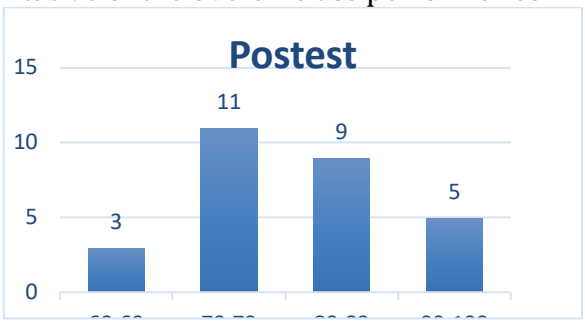


**Figure 2.** Frequency Distribution of Posttest Scores

The frequency distribution of the posttest scores shows that 3 students (10.71%) obtained a score of 65, 11 students (39.29%) scored 75, 9 students (32.14%) achieved a score of 85, and 5 students (17.86%) obtained the highest score of 95. The majority of students scored within the 75–85 range, indicating that most participants achieved good mathematics learning outcomes after participating in the STAD cooperative learning model assisted by Student Worksheets.

Overall, the descriptive analysis demonstrates that the implementation of the Student Teams Achievement Divisions (STAD) cooperative learning model assisted by Student Worksheets effectively improved students' mathematics learning outcomes. This improvement is reflected in the increase in the mean score from 52.89 on the pretest to 80.71 on the posttest, the decrease in the standard deviation from 17.63 to 9.02, and the reduction in the standard error from 3.33 to 1.74. These findings indicate that the instructional model not only enhanced students' mathematics achievement but also produced more consistent and equitable learning outcomes across the class.

***Results of the Questionnaire on the STAD Cooperative Learning Model Assisted by Student Worksheets***

After the completion of the learning process using the Student Teams Achievement Divisions (STAD) cooperative learning model assisted by Student Worksheets, and after all students had completed the posttest, a questionnaire was administered to all participants. The questionnaire aimed to investigate students' responses toward the implementation of the instructional model during the learning process. The questionnaire consisted of 29 statements that had previously been validated and confirmed to be reliable, making it appropriate for data collection.

The descriptive results of the questionnaire are presented in Table 3.

**Table 4.** Frequency Distribution of Questionnaire Scores

| Score (X) | Frequency (f) | fX | $X - \bar{X}$ | $(X - \bar{X})^2$ | $f(X - \bar{X})^2$ |
|---|---|---|---|---|---|
| 80 | 1 | 80 | -8.14 | 66.306 | 66.306 |
| 82 | 1 | 82 | -6.14 | 37.737 | 37.737 |
| 83 | 2 | 166 | -5.14 | 26.449 | 52.898 |
| 84 | 3 | 252 | -4.14 | 17.163 | 51.490 |
| 85 | 2 | 170 | -3.14 | 9.878 | 19.755 |
| 86 | 2 | 172 | -2.14 | 4.592 | 9.184 |
| 87 | 4 | 348 | -1.14 | 1.306 | 5.224 |
| 88 | 3 | 264 | -0.14 | 0.020 | 0.061 |
| 89 | 2 | 178 | 0.86 | 0.735 | 1.469 |

| Score (X) | Frequency (f) | fX | $X - \bar{X}$ | $(X - \bar{X})^2$ | $f(X - \bar{X})^2$ |
|---|---|---|---|---|---|
| 90 | 1 | 90 | 1.86 | 3.449 | 3.449 |
| 92 | 1 | 92 | 3.86 | 14.878 | 14.878 |
| 93 | 1 | 93 | 4.86 | 23.592 | 23.592 |
| 94 | 1 | 94 | 5.86 | 34.306 | 34.306 |
| 95 | 1 | 95 | 6.86 | 47.020 | 47.020 |
| 96 | 1 | 96 | 7.86 | 61.735 | 61.735 |
| 97 | 1 | 97 | 8.86 | 78.449 | 78.449 |
| 99 | 1 | 99 | 10.86 | 117.878 | 117.878 |
| Total | 28 | 2,467 | | | 632.429 |

The descriptive statistical analysis of the questionnaire responses from the 28 students yielded a mean score of 88.11, indicating that students' perceptions of the implementation of the Student Teams Achievement Divisions (STAD) cooperative learning model assisted by Student Worksheets were in the very good category. This result suggests that students responded positively to the instructional model, perceiving it as an effective approach for creating a more active, collaborative, and enjoyable learning environment.

The standard deviation of 4.75 indicates a relatively small dispersion of questionnaire scores, suggesting that students shared similar perceptions regarding the learning model. In other words, students' responses were relatively homogeneous, with only minor variations in their evaluations of the instructional process.

Furthermore, the standard error of 0.91 demonstrates a high level of precision in estimating the population mean. The relatively low standard error indicates that the sample mean accurately represents the overall responses of the participants toward the implementation of the instructional model.

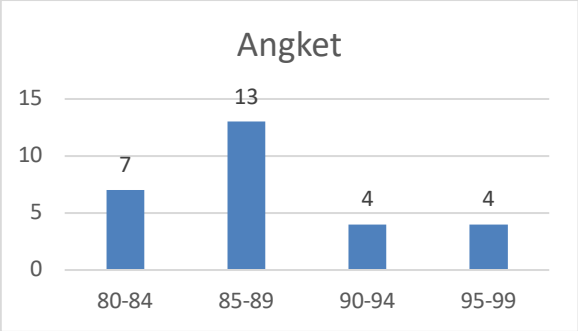


**Figure 3.** Frequency Distribution of Questionnaire Scores

Based on the percentage distribution of questionnaire scores, 7 students (25.00%) obtained scores within the 80–84 interval, 13 students (46.43%) scored within the 85–89 interval, 4 students (14.29%) scored within the 90–94 interval, and 4 students (14.29%) achieved scores within the 95–99 interval. The majority of students were concentrated in the 85–89 score interval, indicating that most participants expressed highly positive perceptions of the implementation of the Student Teams Achievement Divisions (STAD) cooperative learning model assisted by Student Worksheets.

Overall, the questionnaire findings demonstrate that the implementation of the Student Teams Achievement Divisions (STAD) cooperative learning model assisted by Student Worksheets received very positive responses from the students. The instructional model was perceived as effective in increasing students' engagement during classroom activities, promoting collaborative learning, enhancing learning motivation, and facilitating a better understanding of two-dimensional geometry concepts. These findings are consistent with the results of the pretest and posttest analyses, which revealed a substantial

improvement in students' mathematics learning outcomes following the implementation of the instructional model.

### *Data Assumption Testing*

### *Normality Test*

A normality test was conducted to determine whether the research data were normally distributed. This test is one of the prerequisite assumptions that must be satisfied before performing parametric statistical analyses, particularly the Paired Sample t-test. In this study, the data tested included the pretest scores, posttest scores, and questionnaire responses. The normality analysis was performed using IBM SPSS Statistics through the Kolmogorov–Smirnov test with Lilliefors correction and the Shapiro–Wilk test. Since the sample size was fewer than 50 participants (n = 28), the interpretation of normality was based primarily on the Shapiro–Wilk test.

The decision criteria were as follows:

- If the significance value (Sig.) > 0.05, the data are normally distributed.
- If the significance value (Sig.) ≤ 0.05, the data are not normally distributed.

Normality Test of Pretest and Posttest Data

The results of the normality test for the pretest and posttest data are presented in Table 5.

**Table 5.** Normality Test Results of Pretest and Posttest Data

| Data | Kolmogorov–Smirnov Statistic | df | Sig. | Shapiro–Wilk Statistic | df | Sig. | Interpretation |
|---|---|---|---|---|---|---|---|
| Pretest | 0.152 | 28 | 0.097 | 0.959 | 28 | 0.338 | Normal |
| Posttest | 0.124 | 28 | 0.200 | 0.975 | 28 | 0.721 | Normal |

Based on Table 5, the Shapiro–Wilk test produced a significance value of 0.338 for the pretest data and 0.721 for the posttest data. Both values were greater than the significance level of 0.05 (Sig. > 0.05), indicating that the null hypothesis ($H_0$) was accepted. Therefore, both the pretest and posttest data were normally distributed.

Similarly, the Kolmogorov–Smirnov test yielded significance values of 0.097 for the pretest and 0.200 for the posttest, both of which were also greater than 0.05. These findings further confirm that the research data satisfied the assumption of normality.

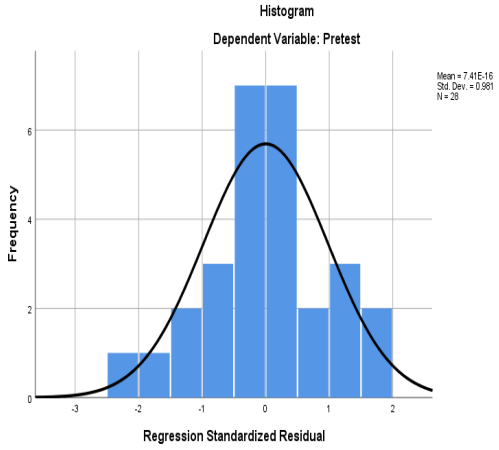


**Figure 4.** Normality Test Diagram of the Posttest Data

Based on these results, it can be concluded that the pretest and posttest data met one of the essential assumptions for parametric statistical analysis. Therefore, the data were appropriate for further hypothesis testing using the Paired Sample t-test.

Normality Test of Questionnaire Data

In addition to the learning achievement data, a normality test was also performed on the questionnaire data, which were used to examine students' responses to the

implementation of the Student Teams Achievement Divisions (STAD) cooperative learning model assisted by Student Worksheets. The results are presented in Table 6.

**Table 6.** Normality Test Results of Questionnaire Data

| Data | Kolmogorov–Smirnov Statistic | df | Sig. | Shapiro–Wilk Statistic | df | Sig. | Interpretation |
|---|---|---|---|---|---|---|---|
| Questionnaire | 0.149 | 28 | 0.115 | 0.945 | 28 | 0.151 | Normal |

As shown in Table 5, the Shapiro–Wilk test produced a significance value of 0.151, which is greater than 0.05 (Sig. > 0.05). Therefore, the null hypothesis ($H_0$) was accepted, indicating that the questionnaire data were normally distributed.

The Kolmogorov–Smirnov test also produced a significance value of 0.115, which exceeded the 0.05 threshold and thus supported the findings obtained from the Shapiro–Wilk test.

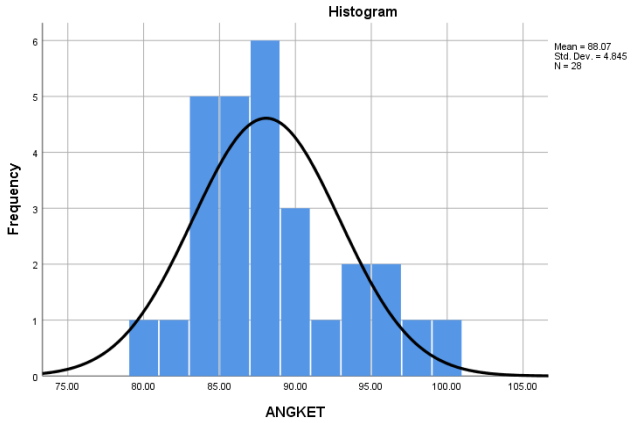


**Figure 5.** Normality Test Diagram of the Questionnaire Data

In conclusion, the questionnaire data fulfilled the assumption of normality and were therefore suitable for parametric statistical analyses. These findings indicate that all research data—including the pretest scores, posttest scores, and questionnaire responses—were normally distributed, satisfying the assumptions required for subsequent analyses, including Pearson Product–Moment correlation analysis, the coefficient of determination ($R^2$), the Paired Sample t-test, and other parametric statistical procedures.

***Coefficient of Determination Test***

The coefficient of determination test was conducted to determine the magnitude of the contribution of the independent variable (X), namely the Student Teams Achievement Divisions (STAD) cooperative learning model assisted by Student Worksheets, to the dependent variable (Y), namely students' Mathematics learning outcomes. The coefficient of determination ($R^2$) was calculated based on the Pearson Product–Moment correlation coefficient obtained from the previous analysis.

The results indicated that the coefficient of determination ($R^2$) was 64.64%, meaning that the implementation of the Student Teams Achievement Divisions (STAD) cooperative learning model assisted by Student Worksheets explained 64.64% of the variance in the Mathematics learning outcomes of third-grade students at SD Negeri 060973 Medan.

The remaining 35.36% of the variance was influenced by other variables that were not examined in this study. These variables may include students' learning motivation, prior mathematical ability, learning interest, family support, classroom learning environment, teacher competence, learning facilities, and other internal and external factors that potentially affect students' academic achievement.

Therefore, it can be concluded that the Student Teams Achievement Divisions (STAD) cooperative learning model assisted by Student Worksheets provides a substantial contribution to improving students' Mathematics learning outcomes. These findings suggest

that the instructional model is an effective learning strategy for enhancing students' understanding and achievement in the topic of Plane Geometry at the elementary school level.

***Hypothesis Testing (t-Test)***

After confirming that all research data satisfied the assumptions required for parametric statistical analysis, particularly the assumption of normality, hypothesis testing was conducted to determine whether the Student Teams Achievement Divisions (STAD) cooperative learning model assisted by Student Worksheets had a statistically significant effect on the Mathematics learning outcomes of third-grade students at SD Negeri 060973 Medan. The hypothesis testing was performed using the partial t-test with the assistance of IBM SPSS Statistics Version 25.

The hypotheses formulated in this study were as follows:

Null Hypothesis ($H_0$):

There is no significant effect of the Student Teams Achievement Divisions (STAD) cooperative learning model assisted by Student Worksheets on the Mathematics learning outcomes of third-grade students at SD Negeri 060973 Medan.

Alternative Hypothesis ($H_1$):

There is a significant effect of the Student Teams Achievement Divisions (STAD) cooperative learning model assisted by Student Worksheets on the Mathematics learning outcomes of third-grade students at SD Negeri 060973 Medan.

The decision criteria were established as follows:

1. If the significance value (Sig.) ≤ 0.05, $H_0$ is rejected and $H_1$ is accepted.
2. If the significance value (Sig.) > 0.05, $H_0$ is accepted and $H_1$ is rejected.
3. If the calculated t-value (*t*calculated) > the critical t-value (*t*table), $H_0$ is rejected and $H_1$ is accepted.
4. If the calculated t-value (*t*calculated) ≤ the critical t-value (*t*table), $H_0$ is accepted and $H_1$ is rejected.

The results of the hypothesis test are presented in Table 7.

**Table 7.** Results of the Hypothesis Test (t-Test)

| Model | B | Std. Error | Beta | t | Sig. |
|---|---|---|---|---|---|
| Constant | -13.097 | 22.253 | – | -0.589 | 0.561 |
| STAD Cooperative Learning Model Assisted by Student Worksheets | 0.727 | 0.268 | 0.804 | 2.713 | 0.012 |

Based on the results presented in Table 7, the regression coefficient (B) was 0.727, indicating that the implementation of the Student Teams Achievement Divisions (STAD) cooperative learning model assisted by Student Worksheets had a positive effect on students' Mathematics learning outcomes. The standard error of 0.268 suggests that the regression coefficient was estimated with an acceptable level of precision.

Furthermore, the standardized regression coefficient (β) was 0.804, indicating a very strong positive relationship between the independent and dependent variables. The analysis also yielded a calculated t-value of 2.713 with a significance value of 0.012.

At the 5% significance level (α = 0.05) and with a sample size of 28 students ($df = n - 2 = 26$), the critical t-value was 2.056. Since the calculated t-value (2.713) was greater than the critical value (2.056) and the significance value (0.012) was lower than 0.05, the null hypothesis ($H_0$) was rejected and the alternative hypothesis ($H_1$) was accepted.

These findings demonstrate that the Student Teams Achievement Divisions (STAD) cooperative learning model assisted by Student Worksheets has a positive and statistically significant effect on the Mathematics learning outcomes of third-grade students at SD Negeri 060973 Medan.

The effectiveness of this instructional model can be attributed to its emphasis on collaborative learning, active student participation, peer interaction, and structured learning activities provided through Student Worksheets. Working collaboratively in heterogeneous groups enables students to exchange ideas, discuss mathematical concepts, solve problems collectively, and support one another in understanding the topic of Plane Geometry. The Student Worksheets further guide students through systematic learning activities, encouraging active engagement and conceptual understanding.

These findings are supported by the substantial improvement in students' achievement, as reflected in the increase in the mean score from 52.89 on the pretest to 80.71 on the posttest. In addition, the reduction in score variability after the intervention indicates that the instructional model not only improved students' average achievement but also promoted more consistent learning outcomes across the class.

Overall, the results suggest that the Student Teams Achievement Divisions (STAD) cooperative learning model assisted by Student Worksheets is an effective instructional approach for improving Mathematics learning outcomes among elementary school students and may serve as a valuable alternative strategy for teaching Plane Geometry in third-grade classrooms.

### *Discussion*

This study was conducted at SD Negeri 060973 Medan during the 2025/2026 academic year to investigate the effect of the Student Teams Achievement Divisions (STAD) cooperative learning model assisted by Student Worksheets on the Mathematics learning outcomes of third-grade students in the topic of Plane Geometry. The study involved 28 students, who were selected using the total sampling technique, meaning that all members of the population participated as research subjects. Data were collected using a Mathematics achievement test and a student response questionnaire, both of which had been tested for validity and reliability before being administered.

The initial stage of the study involved testing the validity and reliability of the research instruments. The validity analysis indicated that 28 out of 40 multiple-choice test items were valid, while 29 out of 50 questionnaire statements met the validity criteria. Reliability testing using Cronbach's Alpha revealed that the achievement test obtained a reliability coefficient of 0.865, indicating very high reliability, whereas the questionnaire obtained a coefficient of 0.783, indicating high reliability.

These findings demonstrate that the research instruments were capable of measuring the intended variables accurately and consistently, making them appropriate for data collection. A valid instrument ensures that each item effectively measures the intended learning indicators, whereas a reliable instrument consistently produces stable results under similar conditions. These findings are consistent with Arikunto (2023), who stated that a good research instrument must satisfy two essential requirements: validity and reliability. Valid instruments measure what they are intended to measure, while reliable instruments generate consistent and dependable results.

The descriptive analysis of the pretest revealed a mean score of 52.89, which was below the school's Minimum Learning Achievement Criterion (KKTP). The standard deviation of 17.63 indicated considerable variation in students' initial abilities, while the standard error of 3.33 suggested that the sample mean adequately represented the population.

The relatively low pretest performance indicates that most students experienced difficulties in understanding the concepts of Plane Geometry before the intervention. This condition can be attributed to the predominance of conventional teacher-centered

instructional methods, which provided limited opportunities for students to actively construct their own mathematical understanding.

These findings support the principles of constructivist learning theory, which emphasizes that meaningful learning occurs when students actively participate in constructing knowledge through interaction and experience. Likewise, Slavin (2015) argues that cooperative learning enhances academic achievement by encouraging interaction among students, enabling them to assist one another in mastering learning materials through collaborative activities.

Following the implementation of the Student Teams Achievement Divisions (STAD) cooperative learning model assisted by Student Worksheets, students' learning outcomes improved substantially. The mean posttest score increased to 80.71, representing an improvement of 27.82 points compared with the pretest mean. Moreover, the standard deviation decreased from 17.63 to 9.02, indicating that students' learning achievements became more homogeneous after the intervention. Similarly, the standard error decreased to 1.74, suggesting that the posttest mean more accurately represented the overall achievement of the participants.

This significant improvement demonstrates that the implementation of the STAD learning model supported by Student Worksheets effectively facilitated students' understanding of Plane Geometry through collaborative group discussions, peer tutoring, cooperative problem-solving, and structured learning activities provided by the worksheets. These learning experiences encouraged students to become more actively involved in constructing mathematical concepts rather than passively receiving information from the teacher.

The findings of this study support Slavin (2015), who identified STAD as one of the most effective cooperative learning models for improving academic achievement because it integrates heterogeneous group collaboration, individual accountability, individual quizzes, and group recognition. Through these components, students actively construct their understanding while simultaneously developing communication and teamwork skills, leading to improved academic performance.

Furthermore, these findings are consistent with previous empirical studies reporting that the STAD cooperative learning model significantly improves Mathematics achievement, learning motivation, classroom participation, collaborative skills, and students' engagement in elementary school settings.

The questionnaire analysis also revealed highly positive student perceptions of the instructional model. The mean questionnaire score was 88.11, indicating a very positive response toward the implementation of the STAD cooperative learning model assisted by Student Worksheets. The standard deviation of 4.81 suggests relatively homogeneous responses among students, while the standard error of 0.91 indicates that the sample mean accurately represented the perceptions of the participants.

These findings indicate that students responded very positively to the instructional approach. Throughout the learning process, students actively participated in group discussions, confidently expressed their ideas, cooperated effectively with peers to complete group assignments, and demonstrated greater confidence when presenting the results of their discussions. Such active engagement contributed not only to improved academic achievement but also to the development of communication, collaboration, and problem-solving skills.

These results support Trianto (2017), who emphasized that cooperative learning promotes social interaction, teamwork, responsibility, and active participation because instruction is centered on students rather than teachers. Moreover, the use of Student

Worksheets provides structured learning experiences that guide students through observing, discussing, solving problems, and drawing conclusions systematically, thereby enhancing conceptual understanding.

Prior to hypothesis testing, the normality assumption was examined using both the Kolmogorov–Smirnov test with Lilliefors correction and the Shapiro–Wilk test. The significance values obtained for the pretest (0.338), posttest (0.721), and questionnaire data (0.151) were all greater than 0.05, indicating that the data were normally distributed.

The fulfillment of the normality assumption confirmed that the dataset was suitable for further parametric statistical analyses, including correlation and hypothesis testing. This finding is consistent with Sugiyono (2023), who argued that normality testing is a prerequisite for parametric statistical procedures to ensure the validity and reliability of statistical conclusions.

The Pearson Product–Moment correlation analysis produced a correlation coefficient of 0.804, indicating a very strong positive relationship between the implementation of the Student Teams Achievement Divisions (STAD) cooperative learning model assisted by Student Worksheets and students' Mathematics learning outcomes.

Furthermore, the coefficient of determination ($R^2$) was 64.64%, indicating that approximately 64.64% of the improvement in students' Mathematics achievement could be explained by the implementation of the instructional model. The remaining 35.36% of the variance was attributed to other factors outside the scope of this study, such as students' learning motivation, prior knowledge, learning environment, family support, and individual characteristics.

According to Sugiyono (2023), a higher correlation coefficient reflects a greater contribution of the independent variable to the dependent variable. Therefore, the findings indicate that the STAD cooperative learning model assisted by Student Worksheets contributed substantially to improving students' Mathematics achievement.

The hypothesis testing using the t-test yielded a calculated t-value of 2.713 with a significance value of 0.012. Since the significance value was lower than 0.05, the null hypothesis ($H_0$) was rejected and the alternative hypothesis ($H_1$) was accepted. These results indicate that the Student Teams Achievement Divisions (STAD) cooperative learning model assisted by Student Worksheets had a positive and statistically significant effect on the Mathematics learning outcomes of third-grade students at SD Negeri 060973 Medan.

These findings further reinforce Slavin's (2015) theory that STAD enhances academic achievement by encouraging cooperative discussions, peer tutoring, individual accountability, and group rewards. Student-centered learning environments enable learners to construct deeper conceptual understanding than traditional teacher-centered instruction.

The findings are also in agreement with Hermawan (2025), who argued that learning outcomes encompass improvements in students' knowledge, skills, and attitudes following participation in instructional activities. The substantial increase in posttest scores, together with students' highly positive responses, demonstrates that the STAD cooperative learning model assisted by Student Worksheets not only enhanced students' mastery of mathematical concepts but also fostered collaboration, communication skills, responsibility, and self-confidence throughout the learning process.

Overall, the results of this study demonstrate that the Student Teams Achievement Divisions (STAD) cooperative learning model assisted by Student Worksheets is effective in improving the Mathematics learning outcomes of third-grade students at SD Negeri 060973 Medan. Its effectiveness is evidenced by the significant improvement in students' achievement, highly positive student responses, the very strong relationship between the instructional model and learning outcomes, and the statistical confirmation of the research

hypothesis. Therefore, this instructional model can be recommended as an effective alternative for teaching Mathematics in elementary schools because it promotes active, collaborative, meaningful, and student-centered learning.

## Conclusion

Based on the findings and discussion of this study regarding the effect of the Student Teams Achievement Divisions (STAD) cooperative learning model supported by Student Worksheets on the mathematics learning outcomes of Grade III students at SD Negeri 060973 Medan during the 2025/2026 academic year, the following conclusions can be drawn.

1. The implementation of the STAD cooperative learning model supported by Student Worksheets received highly positive responses from the students. This finding is evidenced by the questionnaire results, which yielded a mean score of 88.11, with scores ranging from 80 to 99, indicating a very good level of student response. The students reported being more actively engaged, enthusiastic, and motivated throughout the learning process, particularly during group discussions, collaborative activities, and problem-solving tasks facilitated through Student Worksheets.
2. The implementation of the STAD cooperative learning model supported by Student Worksheets significantly improved students' mathematics learning outcomes. The mean pretest score increased from 52.89 to 80.71 on the posttest, representing an improvement of 27.82 points. This substantial increase demonstrates that students achieved a better understanding of plane geometry concepts after participating in learning activities using the STAD cooperative learning model. Furthermore, the decrease in the standard deviation indicates that students' achievement became more consistent and evenly distributed after the instructional intervention.
3. The hypothesis testing confirmed that the STAD cooperative learning model supported by Student Worksheets had a positive and statistically significant effect on students' mathematics learning outcomes. The regression analysis produced a t-value of 2.713 with a significance value of 0.012 ($p < 0.05$), leading to the rejection of the null hypothesis ($H_0$) and the acceptance of the alternative hypothesis ($H_1$). In addition, the coefficient of determination ($R^2$ = 64.64%) indicates that the instructional model accounted for 64.64% of the variance in students' mathematics learning outcomes, while the remaining 35.36% was attributable to other factors not examined in this study, such as students' prior knowledge, learning motivation, family support, learning environment, and individual characteristics.

Overall, the findings demonstrate that the Student Teams Achievement Divisions (STAD) cooperative learning model supported by Student Worksheets is an effective instructional approach for improving mathematics learning outcomes among elementary school students. The model not only enhances students' academic achievement but also promotes active participation, collaborative learning, communication skills, responsibility, and learning motivation. These results suggest that the integration of STAD with Student Worksheets can serve as an effective student-centered instructional strategy for teaching mathematics, particularly on the topic of plane geometry, and may be considered a valuable alternative for elementary school mathematics instruction. Future research is recommended to examine the effectiveness of this instructional model in different educational settings, larger samples, and various mathematics topics to strengthen the generalizability of the findings.

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