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Exploring the Impact of the STAD Cooperative Learning Model on Learning Outcomes in Vocational High Schools

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ABSTRACT

This study examines the impact of the Student Team Achievement Division (STAD) cooperative learning model on student learning outcomes in technical education, specifically focusing on "The Application of Electronic Circuits" at SMKN 1 Sutera. The study employed a quasi-experimental design in which two classes were selected as samples: an experimental group taught using the STAD model and a control group utilizing direct instruction. Posttest results revealed that the experimental group achieved significantly higher average scores (80.00) compared to the control group (71.43), with a lower standard deviation (9.40) indicating more consistent learning outcomes. Normality and homogeneity tests confirmed the validity of the dataset, while hypothesis testing ($t_{calculated}$ = 5.73, t_{table} = 1.679, α = 0.05) demonstrated the significant effectiveness of the STAD model. The findings highlight STAD's ability to foster collaboration, inclusivity, and equitable learning, effectively bridging theoretical knowledge and practical skills gaps. This research addresses a gap in the application of cooperative learning models within technical education and offers actionable insights for enhancing teaching strategies in vocational contexts. Future studies should explore the long-term effects of STAD on skill application, student motivation, and knowledge retention, contributing to the broader discourse on innovative pedagogical approaches in education.

Keywords: Learning Model; Student Teams Achievement Divisions (STAD); Learning Outcomes

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1. INTRODUCTION

Education is a deliberate and planned effort undertaken by educators to transform an individual's or group's behavior, aiming to foster maturity through teaching and learning processes [1]. As defined by experts, it constitutes a systematic pursuit of knowledge transferred from one person to another. Through this process, education seeks to alter behavior toward intellectual and personal maturity, whether in formal or informal settings [2]. Education strives to unlock human potential by providing structured learning experiences in formal, non-formal, and informal education. These experiences occur within and outside schools, persisting throughout life, to optimize individual abilities to effectively fulfill future roles [3].

Fundamentally, education involves the conscious and systematic transfer of knowledge to transform human behavior and promote maturity through various educational modalities. Vocational High Schools (In Indonesia: SMK) enhance human resources by developing intermediate-level individuals with knowledge, skills, and attitudes aligned with their vocational specializations [4]. At SMKN 1 Sutera, the teaching-learning process predominantly relies on teacher-centered methods. Students frequently listen to teachers delivering and explaining lessons, as teachers are the primary source of learning materials. This situation often results in a misalignment between the lesson plans and the predetermined learning models, causing students to face difficulties in their studies. Specific Criteria for Learning Outcome Achievement (In Indonesia: KKTP) are required to evaluate the success or failure of student learning processes.

The choice of learning model plays a crucial role in improving learning outcomes, and teachers' comprehension of various models is essential. The application of these models must align with students' needs, as each model emphasizes different goals, principles, and core focuses [5]. One effective approach is cooperative learning, where students work collaboratively in groups to master the material [6]. Cooperative learning provides a structured environment where students learn from one another, making the learning process more meaningful through collaboration [7]. The Student Team Achievement Division (STAD) stands out as a straightforward yet effective approach among cooperative learning methods. In STAD, groups of 4-5 students with heterogeneous compositions work together toward common learning objectives. This model includes specific components such as learning objectives, material delivery, group activities, quizzes, and rewards [8]. STAD is particularly suitable for teachers who are newly adopting cooperative learning. It encourages students to voice their opinions, respect differing perspectives, and share ideas. Moreover, through practice questions and problem-solving activities, students collaborate and assist one another [9].

Despite the well-documented benefits of the STAD model, limited research has specifically explored its application in teaching technical subjects, such as The Application of Electronic Circuits in vocational high schools. Previous studies have largely focused on general academic subjects like science and mathematics, leaving a gap in understanding its effectiveness in practical and technical learning contexts. Furthermore, there is a lack of empirical evidence on how STAD addresses the unique challenges faced by vocational students, where the integration of practical skills and theoretical knowledge often influences learning outcomes.

Previous research indicates that the STAD learning model can enhance student learning outcomes and achieve mastery [10]. Other studies have found significant differences in Indonesian language learning outcomes between students using the STAD cooperative model and those employing conventional models [11]. Additionally, research highlights the significant impact of STAD on student outcomes, particularly when combined with multipresentation-based student worksheets in teaching physics at senior high schools [12].

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Building on these findings, this study seeks to address the identified gaps by investigating the impact of the STAD model on learning outcomes in The Application of Electronic Circuits within the context of vocational high schools. By focusing on SMKN 1 Sutera as a case study, this research aims to provide actionable insights into how cooperative learning approaches can be adapted to enhance vocational students' educational experience and outcomes. Furthermore, the study aims to contribute to the broader discourse on effective teaching methods that bridge the gap between practical skills and theoretical understanding in technical education.

2. METHODS

This study adopts an experimental research design. In essence, experimental research investigates the effect of a treatment on specific outcomes. It employs a quantitative approach to determine the influence of an independent variable (treatment) on a dependent variable (outcome) under controlled conditions [13]. Experimental research aims to explore causal relationships by applying one or more treatment conditions to experimental groups and comparing the results with control groups that do not receive the treatment [14].

The study utilizes a quasi-experimental design, which involves the use of control groups that cannot fully mitigate the influence of external variables affecting the experiment [15]. This research involved two sample classes: the experimental class (XI TAV 1) and the control class (XI TAV 2). The experimental class received treatment through the cooperative learning model known as the Student Team Achievement Division (STAD), while the control class followed the direct instruction model. Subsequently, both classes were taught the same material, "The Application of Electronic Circuits," and were administered identical tests. The learning outcomes from both classes were then observed and analyzed.

2.1 Data Collection Techniques

The primary data collection method used in this study was evaluative testing. An evaluative test is designed to measure a specific aspect of learning within a predefined framework and methodology. The instrument used in this research was a posttest to assess the learning outcomes of the two sample groups.

2.2. Data Analysis Techniques

2.2.1. Mean is calculated using the following formula (1):

$$\overline{X} = \frac{\sum X}{N} \quad (1)$$

$\overline{X}$ Mean
X Individual scores
N Number of observations

2.2.2. Standard Deviation

The standard deviation (S) is calculated using the following formula(2):

$$S = \sqrt{\frac{\Sigma(Xi-\bar{X})^2}{N-1}} \quad (2)$$

S Sample standard deviation
X Observed values
$\overline{X}$ Sample mean

N Number of observations

2.2.3. Variance

The variance (S^2) is determined by the formula (3):

$$S^2 = \sqrt{S^2} \quad (3)$$

Where Srepresents the sample standard deviation.

2.3. Inferential Analysis

2.3.1. Normality Test

The normality test determines whether the data follows a normal distribution. This study applied the Liliefors test at a significance level of 0.05. The experimental and control class data, including post-test results, were analyzed using this method. A dataset is normally distributed if the calculated Liliefors value (L_0) is smaller than the critical table value (L_{table}).

2.3.2. Homogeneity Test

The homogeneity test assesses whether the two samples have equal variances. The F-test was employed for this purpose, with the following criteria:

a) If $F_{calculated} \geq F_{table}$, the variances are not homogeneous.
b) If $F_{calculated} < F_{table}$, the variances are homogeneous.

2.3.3. Hypothesis Testing

1) If the data are normally distributed and both groups are homogeneous, a t-test is conducted to evaluate the statistical hypothesis [16]. Two formulas can be applied depending on the variance:

Separated Variances

$$t_{calculated} = \frac{(\bar{X}_1 - \bar{X}_2)}{\sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}}} \quad (4)$$

Pooled Variances

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\left[\frac{(n_1 - n_2)S_1{}^2 + (n_2 - 1)S_2{}^2}{n_1 + n_2 - 1}\right]\left[\frac{1}{n_1} + \frac{1}{n_2}\right]}} \quad (5)$$

$\bar{X}_1$ Mean score of the experimental class
$\bar{X}_2$ Mean score of the control class
S_1 Standard deviation of the experimental class
S_2 Standard deviation of the control class
n_1 Number of students in the experimental class
n_2 Number of students in the control class

2) The calculated t-value is then compared with the critical $t$value from the t-distribution table at a 0.05 significance level. The hypothesis testing criteria are:

- Reject $H0$, accept $H1$, if $t$calculated > $t$table
- Accept $H0$, reject $H1$, if $t$calculated ≤ $t$table

3. RESULTS

3.1. Descriptive Data Analysis

3.1.1. Control Group

Based on Table 1, the descriptive data analysis for the control group after the posttest reveals that the average posttest score was 71.43, with a standard error of 3.24. The median score was 72, and the mode was 80, indicating that the majority of students scored around this value. The standard deviation of 12.13 reflects a significant level of variation or dispersion in the data. The sample variance, calculated at 147.34, further highlights the diversity in scores within the group.

Although the kurtosis value of -1.40 indicates a flatter distribution compared to the normal curve, the skewness value of -0.09, which is close to zero, suggests the distribution is relatively symmetrical. These findings clearly represent the data distribution characteristics within the control group.

Table 1. Descriptive Data for Posttest (Control Group)

Descriptive Data	
Mean	71.43
Standard Error	3.24
Median	72
Mode	80
Standard Deviation	12.13
Sample Variance	147.34
Kurtosis	-1.40
Skewness	-0.09
Range	36
Minimum	52
Maximum	88
Sum	1000
Number of Data	14

The range of scores, calculated as the difference between the maximum and minimum values, was 36. The minimum score was 52, while the maximum score was 88. These results indicate a considerable variation in student achievement on the posttest. Based on Figure 1, the highest frequency of scores was observed in the interval of 80, with three students achieving this score. Furthermore, 40% of the students scored above the predetermined Criteria for Learning Outcome Achievement, demonstrating a moderate overall success within the control group.

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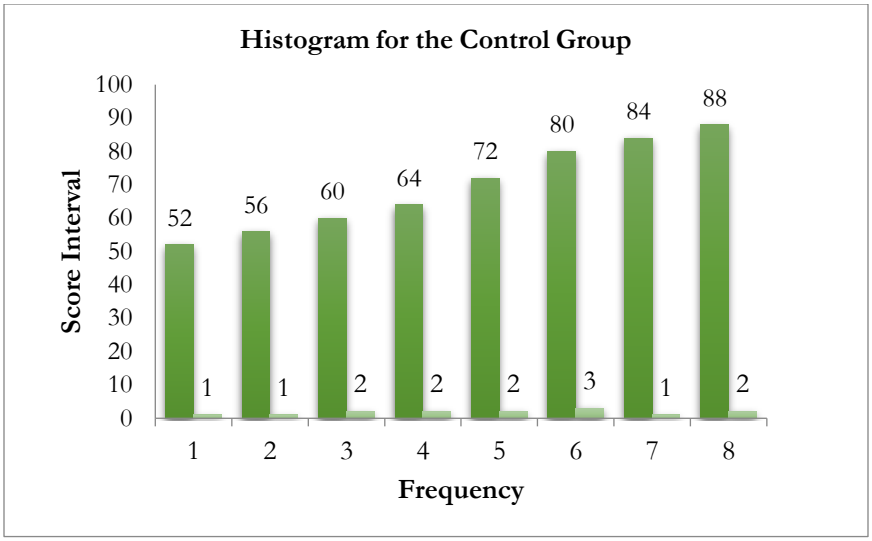

Figure 1. Distribution of Posttest Data for the Control Class

3.1.2. Experimental Group

Based on Table 2, the descriptive data for the experimental group after the posttest shows that the average posttest score was 80, with a standard error of 2.21. The median and mode scores were also 80, indicating that most students consistently scored around this value.

Table 2. Descriptive Data for Posttest (Experimental Group)

Data Description	
Mean	80
Standard Error	2.21
Median	80
Mode	80
Standard Deviation	9.40
Sample Variance	88.47
Kurtosis	1.31
Skewness	-1.09
Range	36
Minimum	56
Maximum	92
Sum	1440
Number of Data	18

The standard deviation, calculated at 9.40, reflects a relatively lower variability level than the control group. The sample variance, 88.47, also indicates a more controlled dispersion of scores within the experimental group.

The kurtosis value of 1.31 suggests a positive kurtosis, indicating a taller and more heavy-tailed distribution compared to the normal distribution. Meanwhile, the skewness value of -1.09 indicates a negative skew, with the data distribution leaning to the left.

The range of scores, calculated as the difference between the maximum and minimum values, was 36, with a minimum score of 56 and a maximum score of 92. These results highlight a considerable variation in student performance, although the variability is more controlled than the control group.

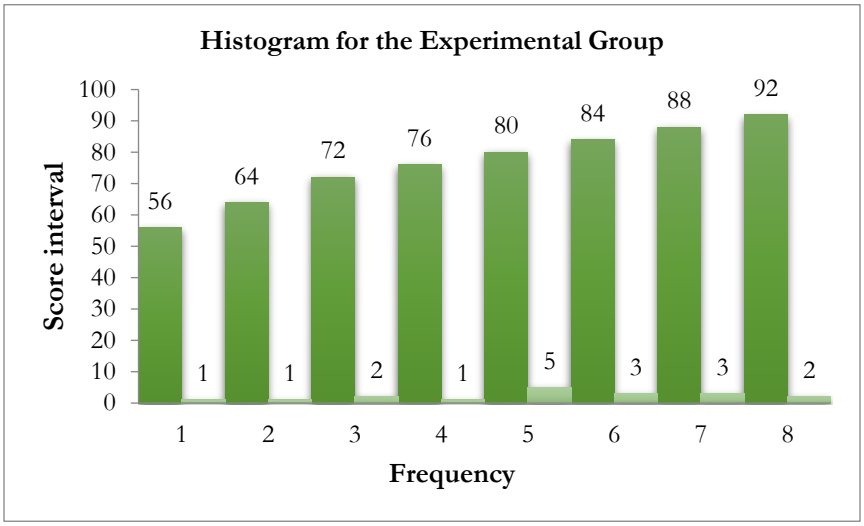

Figure 2. Grafik distribusi data *Posttest* kelas eksperimen

Based on Figure 2, the highest frequency of scores in the experimental group was observed in the 80 interval, with five students achieving this score. It is evident that the experimental group, taught using the STAD model, achieved a higher average score than the control group, which followed the direct instruction model. This finding highlights the effectiveness of the STAD cooperative learning approach in improving student learning outcomes, particularly when compared to conventional teaching methods.

3.2. Inductive Data Analysis

3.2.1. Normality Test

Based on the normality test results shown in Table 3, it was found that both sample classes have $L_0 < L_t$. This indicates that the data from both sample classes are normally distributed.

Table 3. Normality Test Results

Normality Test	N	Lo	Lt	Description
Experimental Group	18	0,101	0,200	Normal
Control Group	14	0,158	0,227	Normal

3.2.2. Homogeneity Test

The homogeneity test results in Table 4 indicate that $F_{calculated} < F_{table}$ (1.29 < 2.50). This confirms that the variances of the two sample groups are homogeneous.

Table 4. Homogeneity Test Results

Sample	Dk = n-1	Si^2
Experimental Group	18	9.40
Control Group	14	12.13
Fcalculated	12.13/9.40 = 1.29	
Ftable	2.50	
Fcalculated < Ftable	1.29 < 2.50	
Keterangan	**Homogeneous**	

3.2.3. Hypothesis Testing

Based on the comparison between $t_{calculated}$ dan t_{table} in Table 5, it is evident that ($t_{calculated} > t_{table}$) or (5.73 > 1.679). This result indicates that H_0 is rejected, and H_1 is accepted. Therefore, the null hypothesis is rejected, which means that the application of the STAD cooperative learning model has a significant effect on student learning outcomes.

Table 5. Hypothesis Testing Results

Group	Average	$T_{calculated}$	T_{table} $\alpha = 0,05$
Experimental	80,00	5.73	1,679
Control	71.43		

4. DISCUSSION

4.1. Descriptive Data Discussion

In the control group, the average posttest score was 71.43, with a standard deviation of 12.13, indicating a relatively high variation in student learning outcomes within this group. Most students achieved posttest scores around 80, which was the mode of the data. However, the data distribution was relatively flat (kurtosis = -1.40) and symmetric (skewness = -0.09), meaning that the scores were evenly distributed around the central value, with no strong tendency toward either extreme. This suggests that the direct instruction approach in the control group resulted in varied student achievements, with a moderate spread of scores and no extreme outliers.

Conversely, in the experimental group treated with the STAD model, the average posttest score was higher at 80, with a lower standard deviation (9.40), indicating more controlled variation compared to the control group. Most students in the experimental group achieved consistent learning outcomes, as evidenced by the mode, median, and mean, all being 80. The negative skewness (-1.09) suggests that the distribution leaned slightly toward lower scores, although most students scored within the higher range. Additionally, the positive kurtosis (1.31) indicates a taller peak in the data distribution than a normal distribution, suggesting that several students achieved exceptionally high scores.

4.2. Inferential Data Analysis Discussion

The normality test results showed that the data for both sample groups followed a normal distribution (Lo < Lt). This satisfies the normality assumption required for further statistical analysis, ensuring the validity of the hypothesis test. Moreover, the homogeneity test results confirmed that both groups had homogeneous variances ($F_{calculated} < F_{table}$), making the two groups statistically comparable.

The hypothesis testing results indicated a significant difference between the control and experimental groups, with $t_{calculated}$ (5.73) exceeding t_{table} (1.679) at $\alpha = 0.05$. Therefore, the null hypothesis (H_0) was rejected, and the alternative hypothesis (H_1) was accepted. This finding confirms that the application of the STAD cooperative learning model significantly influenced student learning outcomes. The higher average post-test score in the experimental group suggests that the STAD model was more effective than the direct instruction method applied in the control group.

4.3. Comparative Analysis of the Control and Experimental Groups

When comparing the two groups, the experimental group demonstrated higher learning outcomes with a more controlled score distribution than the control group. The lower variation in the experimental group indicates that the STAD model provided more equitable support to students, resulting in less disparity in their achievements. This may be attributed to the collaborative nature of the STAD model, which enables students to learn from and assist one another, thereby improving their understanding and overall performance.

5. CONCLUSION

The findings of this study underscore the significant positive impact of the Student Team Achievement Division (STAD) cooperative learning model on student learning outcomes. The experimental group demonstrated a higher average post-test score (80) than the control group (71.43) and more controlled score variation, as indicated by a lower standard deviation. These results highlight the ability of the STAD model to create a structured and equitable learning environment, fostering individual and collective academic success.

The study also highlights the pedagogical advantages of the STAD model in promoting inclusivity and balanced academic growth. By enabling students to work collaboratively in diverse groups, the model mitigates disparities in achievement and ensures that all learners benefit from shared knowledge and problem-solving. This is particularly critical in contexts where active participation and teamwork are essential for mastering theoretical and practical knowledge.

In light of these findings, the STAD cooperative learning model is recommended as an effective and scalable teaching strategy for improving learning outcomes across various educational contexts. Its adaptability suits subjects requiring collaboration and critical thinking, including vocational, technical, and interdisciplinary domains. Future research could expand on these findings by exploring the long-term effects of STAD on student motivation, retention of knowledge, and application of skills in real-world scenarios.

This study contributes to the broader discourse on innovative pedagogical practices by providing empirical evidence of the efficacy of cooperative learning models. It reinforces the call for adopting student-centered approaches to foster deeper learning and equitable academic achievement in diverse educational settings.

DECLARATIONS

Author's Contributions

Wila Mutiara Yeni: Conceptualization, Methodology, Investigation, Software, Writing - Original Draft. **Hanesman:** Supervision, Validation. **Ilmiyati Rahmy Jasril:** Supervision, Validation. **Sartika Anori:** Supervision. **Kenan Işık:** Supervision, Writing - Review & Editing. **Xue Wan:** Writing - Review & Editing. All authors have read and approved the final version of this manuscript.

Competing Interests

The author declares no competing interests.

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