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Enhancing Science Education Through the Student Teams Achievement Division (STAD) Learning Model: An Experimental Study on Process Skills and Learning Outcomes at Middle School

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ABSTRACT

This study investigates the implementation of the Student Teams Achievement Division (STAD) Learning Model, which emphasizes teamwork and individual accountability. Traditional teaching methods often fail to actively engage students in developing analytical and practical skills. The STAD model aims to enhance students' process skills and learning outcomes in science education. The research was conducted at SMP Muhammadiyah Ambon with seventh-grade students from four classes. Two classes were randomly selected, with class VIIa as the experimental group (30 students) and another class as the control group (30 students). Data were analyzed using descriptive analysis and multivariate analysis (MANOVA) with SPSS version 26.0. A quantitative experimental approach was employed, using a Pre-test, Post-test, and Non-equivalent Control Group design. Data collection focused on science process skills and learning outcomes. The results demonstrated a significant impact of the STAD model on improving learning outcomes and science process skills. There was a notable increase in average scores from pre-test to post-test in both experimental and control groups. MANOVA results (Pillai's Trace, Wilks' Lambda, Hotelling's Trace, and Roy's Largest Root) showed very high F-values, indicating significant differences between the groups in enhancing students' science process skills and learning achievements. The STAD model proved more effective than traditional methods, suggesting its integration into a collaboration-based curriculum. Effective implementation requires STAD-based teacher training, including team formation techniques, motivational strategies, and methods for assessing team performance. Adopting these recommendations can significantly boost student participation, teamwork skills, and overall learning outcomes.

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1. INTRODUCTION

Education is one of the main pillars of building high-quality human resources. The Industrial Revolution 4.0 has introduced fundamental changes in various aspects of life, including work and communication (Tiantong & Teemuangsai, 2017). Technological advancements such as artificial intelligence, robotics, and digitalization have created new demands that require education to keep pace with these developments (Xu et al., 2023). Nowadays, education is about academic knowledge and preparing students with skills relevant to the current era (Asmedy, 2021). In the context of globalization and rapid technological advancement, the education system must provide academic knowledge and develop critical thinking, communication, and collaboration skills. The 21st century demands individuals to have strong critical thinking skills to face complex challenges (Sholikhah et al., 2019), the ability to collaborate in teams, practical communication skills in various contexts, and digital literacy. This condition allows students to adapt to the ever-evolving technology (Widyastuti, 2023). It emphasizes the importance of learning approaches that focus on skill development rather than relying solely on theoretical knowledge (Hariyanto et al., 2023).

Various innovations and models, including cooperative learning, have been developed to meet these demands. Cooperative learning models focus on small-group cooperation among students to achieve shared learning goals. One of the cooperative learning models that has proven effective is the Student Teams Achievement Division (STAD). This model is an educational approach that has significantly evolved in the 21st century. Although the basic principles of cooperative learning have existed for a long time, applying the STAD model in the modern context has shown tremendous benefits in enhancing student collaboration and achievement. This model focuses on group-based learning, where students work together in teams to achieve common goals (Kamid Sri et al., 2022). The STAD model, first developed by Robert Slavin and his colleagues in the late 1970s, has been adapted and refined over the decades to meet the educational needs of the 21st century (Slavin, 1995). In the modern era, global education experts have recognized the STAD model's ability to enhance student collaboration and achievement (Ibrahim & Adnan, 2019; Ngailo et al., 2021). The main advantage of this model lies in its promotion of effective teamwork, which opens opportunities for active collaboration and deeper learning.

This model divides students into heterogeneous groups to help each other complete academic tasks and prepare for individual tests. This approach focuses on small-group collaborative learning and has proven effective in various educational contexts. Several studies have highlighted the benefits of the STAD model in enhancing student collaboration and achievement (Dewi et al., 2020; Kamid, Sri, et al., 2022; Ibrahim & Adnan, 2019; Ngailo et al., 2021). In these groups, students work together to tackle various tasks and problems. Through the proper implementation of the STAD learning model, multiple efforts can be made to improve student academic achievement by engaging students actively in discussions, analysis, and problem-solving (Sholikhah et al., 2019.; Mahadi et al., 2023). The advantage of the STAD model lies in its ability to increase student participation, build social skills, and create an inclusive learning environment. This model encourages interaction among students in sharing understanding and experiences about the material being taught and helps strengthen students' knowledge of the material being taught (Berliner & Deneme, 2021; Rejeki, 2023; Sholehah, 2022).

However, despite the many benefits the STAD model offers, its implementation only sometimes runs smoothly. The educational challenges in the era of the Industrial Revolution 4.0 and the needs of the 21st century are significant issues in today's education (Juliansih et al., 2023). One of the main challenges in education today is integrating 21st-century skills into the existing curriculum and teaching methods to prepare students to face an uncertain and changing future (Dewi et al., 2020). Meanwhile, applying the STAD model in school environments faces several gaps and challenges (Rahmah & Yerizon, 2020). The limitations of technological infrastructure, especially related to limited access to digital devices, are significant barriers. Research has found that more than 50% of schools need more digital devices, posing significant barriers to implementing STAD (Tiantong & Teemuangsai, 2017).

Additionally, uneven teacher training is a significant challenge in implementing the STAD model. Many teachers need sufficient training to implement this method in the classroom effectively. A study shows that about 40% of teachers feel unprepared to use cooperative learning techniques like STAD in daily teaching (Nazari et al., 2021). Adequate support and training ensure that teachers have the skills and knowledge to facilitate student cooperation and achieve optimal learning outcomes (Asmedy, 2021). Other challenges include difficulties managing group dynamics, especially in large classes with diverse student abilities. Effective classroom management requires specific strategies to ensure every student is actively involved and contributes optimally to their groups (Sholikhah et al., 2019); without adequate support and guidance, the application of STAD could be less practical and fail to achieve the expected learning objectives (Hariyanto et al., 2023).

In the modern educational era, where 21st-century skills are heavily emphasized, the STAD model has great potential to help students develop skills relevant to today's needs. Therefore, it is essential to explore further how this model can be implemented effectively. Teachers are crucial in designing tasks and activities appropriate to student abilities, ensuring heterogeneous groups, and providing constructive feedback (Asmedy, 2021). By sharing knowledge within groups, students feel more responsible for learning outcomes (Rahmah & Yerizon, 2020). Regarding process skills, this discussion and shared understanding are essential steps in enhancing student learning activities (Misbah et al., 2023; Tiantong & Teemuangsai, 2017). Additionally, it motivates them to participate actively in learning (Jamilah, 2021; Qureshi et al., 2023). By implementing the STAD learning model, teachers can support students' academic achievement and develop critical thinking, communication, teamwork, and problem-solving skills. It helps students become independent learners and ready to face various challenges in life.

Several studies have highlighted the benefits of the STAD model in enhancing student collaboration and achievement. STAD allows students to work in small teams with diverse abilities, improving academic achievement (Kamid Sri et al., 2022). This model also positively impacts students' social and emotional aspects, including increased student cooperation (Rahmah & Yerizon, 2020). Other research emphasizes the importance of teacher support in facilitating student cooperation. Teacher support can help students cooperate better and achieve optimal learning outcomes (Asmedy, 2021). Additionally, research shows that the STAD model can be effectively implemented in online learning and increase student learning motivation (Afrikani et al., 2020; Takko et al., 2020). However, there are challenges to consider in implementing the STAD model, such as managing large classes and resource limitations (Nazari et al., 2021). Adapting the STAD model for project-based learning environments and reducing inequalities in student achievement are also research focuses (Sholikhah et al., 2019; Rad et al., 2023). Furthermore, good teacher training is a critical factor in the successful implementation of STAD, as trained teachers can better manage group dynamics and ensure every student gains maximum benefit from this method (Qureshi et al., 2023).

SMP Muhammadiyah Ambon is one of the educational institutions that continues to strive to improve the quality of education through various learning innovations. However, challenges in achieving optimal learning outcomes and developing students' process skills remain a significant concern. The monotonous and less innovative learning conditions, especially in science subjects, are a serious concern, especially in achieving adequate Minimum Competency Criteria (KKM) values in this subject. Many students need help to meet the KKM standards set at 70, with the average scores obtained falling below this threshold. This situation is dominated by students who have yet to achieve the expected level of mastery of the material, which directly impacts overall learning outcomes. Although SMP Muhammadiyah Ambon has adequate facilities and infrastructure, the lack of variation in the learning model is the leading cause of less optimal learning. The percentage of students who achieve scores above the KKM is only about 43.35%, while the remaining 56.67% still need to receive scores below the KKM.

Furthermore, limited science learning using conventional methods also negatively impacts the development of practical skills essential in science studies. Mapping skills, spatial data analysis, and geospatial technology are crucial aspects of this subject. However, with the need for more variation in learning approaches, students need help to develop these skills effectively. It can impact students' ability to face real-world challenges in science, such as complex scientific analysis or the application of the latest technology in understanding geospatial problems. Serious efforts are needed to adopt innovative and diverse learning models so that students can achieve better KKM values in science subjects and develop the practical skills they need for the future.

This research aims to investigate the potential use of the STAD model in increasing the effectiveness of science learning, focusing on improving process skills and learning outcomes. This study also aims to provide recommendations that can support teacher training and the development of more innovative curricula in science learning to address the challenges of current conventional teaching methods. The novelty of this research lies in applying the STAD learning model in the context of science learning, which currently faces challenges in conventional teaching methods. This study will comprehensively examine the impact of using STAD on improving process skills and science learning outcomes. The expected results of this research will provide insights for schools and education stakeholders to adopt more innovative learning methods in science subjects and encourage improving learning quality and student achievement.

The significance of this research lies in its contribution to enriching academic literature on cooperative learning methods, especially the STAD model. Additionally, the findings of this study are expected to provide practical insights and recommendations for educators and policymakers in implementing effective and comprehensive learning strategies. Thus, this research is expected to improve the quality of education and the holistic development of student skills.

2. METHODS

This research uses a quasi-experimental or quasi-experiment approach because it is impossible to control all variables that influence the research, which often occurs in educational contexts. The research design was a pre-test, post-test, and non-equivalent control group. This quasi-experimental design aims to assess the similarities between two groups in a study. This study was conducted at SMP Muhammadiyah Ambon, with seventh-grade students from four classes serving as the research population. Two classes were randomly selected, with class VIIa as the experimental class consisting of 30 students and another class as the control class, also consisting of 30 students. This treatment involves using two different learning methods, namely the STAD type learning model and conventional learning, to compare the effectiveness of both in improving students' science learning process skills and outcomes. The randomization process was done: first, each class was assigned a unique identification number. Next, a random number generator selected two classes from the four available classes. Additionally, the researchers were unaware of the class assignments during the selection process to ensure that the process was truly random and to avoid bias. These steps ensured that each class had an equal chance of being selected, strengthening the study's internal validity.

The data collected in this research is quantitative and obtained through process skills tests and science learning outcomes tests. Process skills tests measure students' ability to apply scientific concepts in practical situations, while science learning outcomes tests measure students' knowledge and understanding of science subject matter. To analyze the data obtained, researchers used two analysis techniques, namely descriptive analysis and multivariate analysis (MANOVA), with the help of SPSS statistical software version 26.0 for Windows. Descriptive analysis summarizes and describes data statistically, such as mean; multivariate analysis (MANOVA) was used to test significant differences between the experimental and control groups regarding process skills and science learning outcomes. Using MANOVA, researchers can evaluate the impact of different learning methods on these variables.

To address potential confounding variables that may affect the research results, the researcher will monitor and control factors such as teacher effectiveness, classroom environment, and student motivation. Teacher effectiveness will be controlled by ensuring that all teachers involved have comparable qualifications and experience and by providing special training to ensure the teaching methods are uniformly delivered. The physical and social conditions of the classrooms will be standardized to control the classroom environment, and environmental factors will be monitored during the study to identify and address any changes. Student motivation will be measured using valid and reliable questionnaires before and after the intervention, and the results will be used as covariates in the MANOVA analysis to isolate the influence of motivation on learning outcomes and process skills. These measures aim to minimize bias and enhance the validity of the research results, thereby providing a more accurate picture of the effectiveness of the teaching methods being tested.

3. FINDINGS AND DISCUSSION

In the results section of this study, researchers present an in-depth analysis of students' process skills and learning outcomes, which includes a comprehensive evaluation of their progress. Through systematic data collection, average values are obtained that allow researchers to describe students' general achievements in both aspects while calculating standard deviations, which offers insight into how broad the variations in their performance are. In addition, this research also explores the prerequisite tests needed to ensure statistical validity in data analysis, including normality of distribution and homogeneity of variance. The results of hypothesis testing, a crucial part of the research, reveal significant relationships between the variables under study, confirming or rejecting the initial hypothesis proposed. Thus, this research offers a new perspective on the effectiveness of learning methods on students' process skills and learning outcomes and provides empirical evidence that supports improved educational practices.

A descriptive analysis of data on students' process skills and learning outcomes conducted in this study revealed a comprehensive picture of student performance through descriptive statistics, including average scores that indicate students' general level of achievement. The number of scores processed provides a quantitative measure of how much data was analyzed, adding depth to our understanding of the distribution of student performance. The results, presented in Fig. 1, offer essential insights into the current status of process skills and learning outcomes among students and provide a solid basis for pedagogical recommendations to improve the learning process's effectiveness.

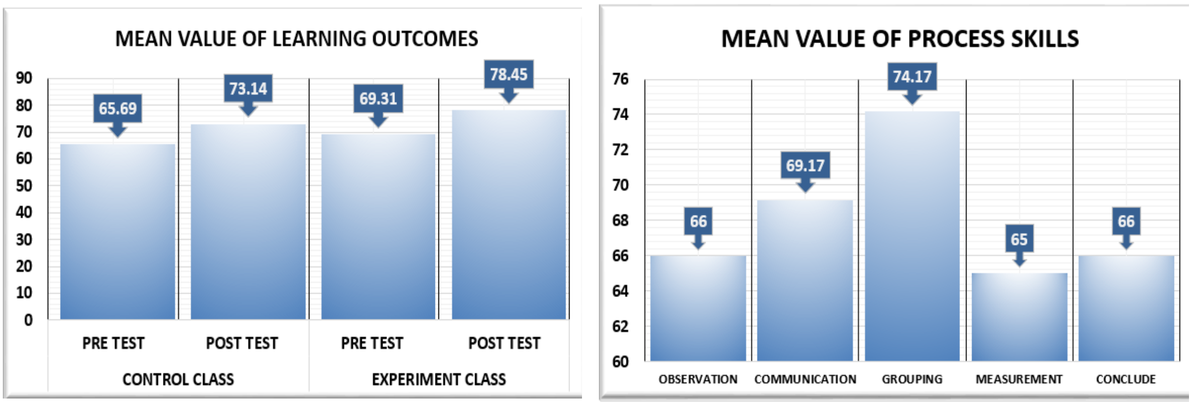


Figure. 1. Mean value of learning outcomes and Process Skills

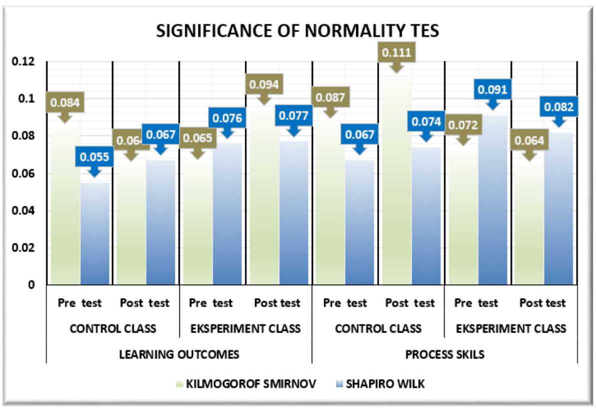
The analysis results in Figure 1 show that implementing the Student Teams Achievement Division (STAD) model has a more significant positive impact on student learning outcomes and process skills than conventional methods. The increase in scores from the pre-test to the post-test was higher in the experimental group (from 69.31 to 78.45) compared to the control group (from 65.69 to 73.14), indicating the effectiveness of the STAD model in enhancing student understanding. These findings align with previous research showing that cooperative learning models, such as STAD, can improve student collaboration and learning outcomes (Slavin, 1995; Kamid, Sri et al., 2022). In the literature, STAD enhances student participation in learning, strengthens social skills, and promotes deeper understanding through discussion and group work (Ibrahim & Adnan, 2019). Other studies also indicate that cooperative learning can reduce student anxiety and increase their learning motivation

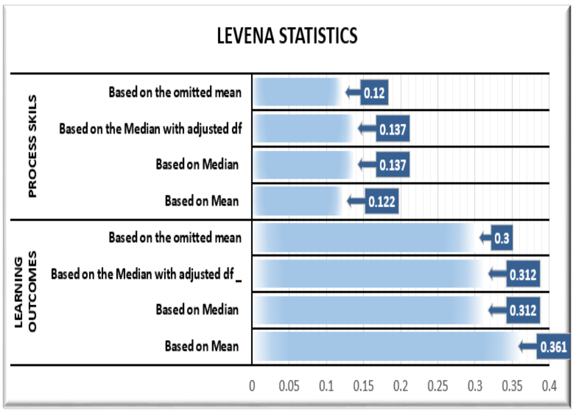
(Ngailo et al., 2021). Implementing the STAD model in the classroom can help teachers create a more inclusive and collaborative learning environment. Teachers can leverage the advantages of the STAD model to improve student process skills, such as observation, communication, and grouping. By dividing students into heterogeneous groups, they can help each other and learn from one another, ultimately enhancing their overall understanding and skills.

The analysis of student process skills shows that aspects such as observation, communication, and grouping experienced significant improvement. The average scores for observation (66.00), communication (69.17), and grouping (74.17) reflect that students involved in the STAD model are better able to observe and record information accurately, convey information clearly, and collaborate effectively in groups. It is crucial in science learning, where these process skills are highly needed for experiments and research. However, some limitations should be considered when implementing the STAD model. First, implementing this model requires adequate teacher training and preparation to ensure they can effectively facilitate student cooperation (Nazari et al., 2021). Second, infrastructural limitations, particularly access to technological devices, can pose barriers to the optimal implementation of STAD (Tiantong & Teemuangsai, 2017). Finally, the diverse group dynamics regarding student abilities and motivation can present challenges in effectively managing the classroom (Sholikhah et al., 2019).

Meanwhile, measurement and inference skills had average scores of 65.00 and 66.00, respectively, illustrating students' ability to measure objects and draw conclusions from gathered data. These statistical results provide a comprehensive overview of the distribution of student process skills, offering guidance for developing more targeted learning strategies and identifying areas that may require special attention for further improvement. Overall, this table analysis provides empirical support for the effectiveness of the STAD model in enhancing student achievement in an experimental learning context.

Before entering the hypothesis analysis stage, it is crucial to conduct prerequisite tests to ensure that the dataset used thoroughly satisfies all essential statistical assumptions, such as normal distribution of data, homogeneity of variances, and collinearity. These assumptions serve as a critical foundation for determining the adequacy of statistical methods. Rigorous prerequisite testing ensures the reliability and validity of subsequent hypothesis testing and guarantees the research's analytical integrity. If the data fails to meet these assumptions, corrective steps, such as data transformation or consideration of alternative statistical methods that are more flexible to assumptions, must be contemplated. The Kolmogorov-Smirnov, Shapiro-Wilk, and Levene results for homogeneity of variances and collinearity tests presented in Fig. 4 provide critical guidance to determine the most appropriate analytical approach. This information aids researchers in gaining a profound understanding of the data characteristics, allowing subsequent analytical steps to be built on a solid foundation, thereby enhancing the accuracy and relevance of research findings.





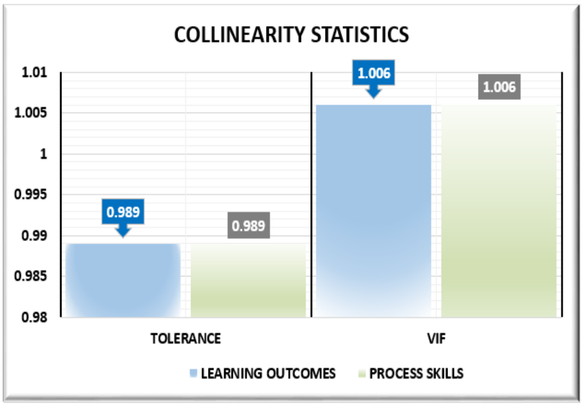


Figure. 2. Prerequisite Testing for Normality, Homogeneity, and Collinearity for Student Learning Outcomes and Process Skills.

Figure 2 provides a comprehensive overview of the prerequisite tests for the Control and Experimental Classes before and after the intervention. Normality tests using Kolmogorov-Smirnov and Shapiro-Wilk methods indicate that most student process skills and learning outcome data tend to follow a normal distribution, with p-values exceeding the significance level of 0.05, commonly accepted in statistical analysis. Homogeneity of variance tests using Levene Statistics confirms no significant differences in variance between groups for learning outcomes and process skills. The high p-values, ranging from 0.781 to 0.835 for learning outcomes and 0.942 to 0.964 for process skills, indicate group homogeneity. Furthermore, the collinearity analysis reveals high tolerance and VIF values for the independent variables of learning outcomes and process skills, indicating the absence of significant collinearity issues affirms that the results from this model are reliable and can be used to make inferences regarding the relationship between the independent and dependent variable "Class." With these findings, it is understood that the statistical analysis in this study is dependable and provides a solid basis for concluding the intervention's impact on student learning outcomes and process skills.

The hypothesis, which states that the *STAD Model* influences learning outcomes and process skills, can be strengthened based on the results of MANOVA analysis and Test of Between-Subjects Effects. MANOVA analysis makes it possible to evaluate the significant impact of the STAD Model on several dependent variables at once, in this case, learning outcomes and process skills, by considering independent variables such as the class or learning method used. The *Test of Between-Subjects Effec*ts results can provide strong evidence about whether the differences between the groups applying the STAD Model and the control group affect learning outcomes and process skills. Thus, this analysis can validate or reject the hypothesis that the STAD Model has varying influences on students' learning outcomes and process skills, which will help in understanding the effectiveness of this learning method in a broader research context. More details regarding this hypothesis test are explained in Tables 1 and 2 below.

Table 1. MANOVA test

Multivariate Tests									
Effect.		**Value.**	**F.**	**Hypoth esis df**	**Error df**	**Sig**	**ɔartial_ ɟuared**	**EtaNoncent_ Parameter**	**Observed_ Power[d]**
Intercept_	Pillai's_ Trace	.996	13463.435[b]	3.000	124.000	.001	.986	26351.170	1.001
	Wilks_' Lambda	.006	13463.435[b]	2.000	124.000	.001	.986	26351.170	1.001
	Hotelling_'s Trace	246.096	13463.435[b]	3.000	124.000	.001	.986	26351.170	1.001
	Roy's_ Largest Root	246.096	13463.435[b]	2.000	124.000	.001	.986	26351.170	1.001
Kelas_	Pillai's_ Trace	.380	8.663	5.000	241.000	.003	.175	53.645	1.004
_	Wilks_' Lambda	.641	9.870[b]	5.000	241.000	.003	.216	58.532	1.004
	Hotelling_'s Trace	.573	12.089	5.000	236.000	.003	.216	65.481	1.004
	Roy's_ Largest Root	.571	21.437[c]	2.000	124.000	.001	.377	66.352	1.004

Table 2. Test of Between

Tests of Between-Subjects Effects									
Source	**Dependent Variable**	**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**	**Partial Eta Squared**	**Consent. Parameter**	**Observed Power**
Corrected Model	K _ P	17.292 [a]	3	5,764	19 .116	. 00 1	.343	12.347	.070
	H _ B	2748.567 [b]	3	916.189	22,413	.000	.367	67.239	1.000
Intercept	K _ P	699976.875	1	699976.875	14045.954	.000	.992	14045.954	1.000
	H _ B	620065.633	1	620065.633	15168.842	.000	.992	15168.842	1.000
Class	K _ P	16.232	2	5.544	.1 20	.951	.003	.347	.070
	H _ B	2468.557	2	926.159	21.423	.000	.367	67.239	1.000
Error	K _ P	5120.823	126	4 8 .845					
	H _ B	4451.810	126	41.868					
Total	K _ P	701985.010	130						
	H _ B	624886.010	130						
Corrected _ Total	K _ P	5248.135	129						
	H _ B	7380.357	129						

Table 1 shows the MANOVA test results show significant differences in the dependent variables analyzed between class groups as expressed by the statistically significant values of various MANOVA metrics, such as Pillai's Trace, Wilks' Lambda, Hotelling's Trace, and Roy's Largest Root, which are close to 1 with very high F values. These findings indicate that class variables, both in the experimental and control classes, significantly impact the dependent variables tested. Apart from that, the reasonably high Partial Eta Squared value also indicates that the class variable substantially contributes to the variation in the dependent variables. Therefore, within-class groups play an essential role in explaining the differences observed in the dependent variables in this study. These results confirm the importance of the influence of class factors on students' learning outcomes and process skills and strengthen the significance of the findings in this research.

Table 2 presents the analysis results of "Tests of Between-Subjects Effects," which reveal significant differences in learning outcomes between different class groups as reflected in the high F value (F=22.413) and very low p-value (Sig.) (<0.001). These results indicate that the learning model or class significantly impacts student learning outcomes, with approximately 36.7% of the variation in learning outcomes explained by this variable. In addition, process skills (KP) also show significant differences between class groups, with a significant F value (F=19.116) and a low p-value (0.001). In addition, the Partial Eta Squared value for process skills (KP) is around 0.343, indicating that the learning model or class dramatically impacts students' process skills. Therefore, student learning outcomes are more influenced by the learning model or class than their process skills. These findings provide significant insights in the context of this research, highlighting the critical role of learning models in influencing student learning outcomes.

Furthermore, assessing the significance of the difference in the average score of process skills and the estimated average score of learning outcomes is the essence of the statistical analysis in this research. Through this analysis, we can identify whether there are significant differences in students' process skills and the learning outcomes they achieve between the group that applies the STAD Model and the control group. Effective results prove that the STAD Model has differential effects on these two variables, which could have significant implications in the learning context. The analysis results can be found in Tables 3 and 4 for more detailed information.

Table 3. Average of Process Skills

Dependent Variable: Process Skills						
(I) Aspect	**(J) Aspect**	**Mean Difference (IJ)**	**Std Error**	**Sig**	**95% Confidence Interval.**	
					Lower Bound.	**Upper Bound.**
Observation	Communication	.167	1.817	.027	-3.42	3.75
	Grouping	-.833	1.817	.047	-4.42	2.75
	Measurement	-.167	1.817	.027	-3.75	3.42
	Conclude	-.500	1.817	.043	-4.09	3.09
	Forecast	-.500	1.817	.043	-4.09	3.09
Communication	Observation	-.167	1,817	.027	-3.75	3.42
	Grouping	-1.000	1,817	.043	-4.59	2.59
	Measurement	-.333	1.817	.045	-3.92	3.25
	Conclude	-.667	1.817	.014	-4.25	2.92
	Forecast	-.667	1.817	.014	-4.25	2.92
Grouping	Observation	.833	1.817	.047	-2.75	4.42
	Communication	1.000	1.817	.033	-2.59	4.59
	Measurement	.667	1.817	.014	-2.92	4.25
	Conclude	.333	1.817	.045	-3.25	3.92
	Forecast	.333	1.817	.045	-3.25	3.92
Measurement	Observation	.167	1.817	.027	-3.42	3.75
	Communication	.333	1.817	.055	-3.25	3.92
	Grouping	-.667	1.817	.014	-4.25	2.92
	Conclude	-.333	1.817	.035	-3.92	3.25
	Forecast	-.333	1.817	.045	-3.92	3.25
Conclude	Observation	.500	1.817	.043	-3.09	4.09
	Communication	.667	1.817	.014	-2.92	4.25
	Grouping	-.333	1.817	.055	-3.92	3.25
	Measurement	.333	1.817	.045	-3.25	3.92
	Forecast	.000	1.817	.000	-3.59	3.59
Forecast	Observation	.500	1.817	.043	-3.09	4.09
	Communication	.667	1.817	.014	-2.92	4.25
	Grouping	-.333	1.817	.045	-3.92	3.25
	Measurement	.333	1.817	.025	-3.25	3.92
	Conclude	.000	1.817	.000	-3.59	3.59

Table 3 shows several significant differences in the average score of process skills (KP) between the various aspects tested. The analysis results using the Least Significant Difference (LSD) method show that this difference is significant at the 0.05 confidence level. Some considerable differences include differences in observation by inference, forecasting by inference, and forecasting by measurement, which means these aspects significantly differ in students' processing skills. However, the differences between other elements could be more effective. These findings provide important insights into students' process skills in various aspects, which can serve as a basis for further improvement and development in learning contexts. These results provide a deeper understanding of differences in students' process skills and which areas may need more attention to improve the quality of learning.

Table 4. Average of Learning Outcomes

(i) Class.	(J) Class.	Mean. Difference (IJ)	Std Error	Sig	95% Confidence Interval Lower Bound	Upper Bound
Pre-test Control	Post-test Control Class	-3.333 *	1.651	.046	-6.60	-.06
	Pre-test Experiment Class	-7.367 *	1.651	.000	-10.64	-4.10
	Post-test Experiment Class	-12.833 *	1.651	.000	-16.10	-9.56
Post-test Control	Post-test Control Class	3.333 *	1.651	.046	.06	6.60
	Pre-test Experiment Class	-4.033 *	1.651	.016	-7.30	-.76
	Post-test Experiment Class	-9.500 *	1.651	.000	-12.77	-6.23
Pre-test Experiment	Post-test Control Class	7.367 *	1.651	.000	4.10	10.64
	Pre-test Experiment Class	4.033 *	1.651	.016	.76	7.30
	Post-test Experiment Class	-5.467 *	1.651	.001	-8.74	-2.20
Post-test Experiment	Post-test Control Class	12.833 *	1.651	.000	9.56	16.10
	Pre-test Experiment Class	9.500 *	1.651	.000	6.23	12.77
	Post-test Experiment Class	5.467 *	1.651	.001	2.20	8.74

Table 4 shows significant differences in the average estimated learning outcomes and scores between different class groups. Analysis using the Least Significant Difference (LSD) method shows that this difference has a significance level of 0.05. More specifically, the estimated average score of learning outcomes on the post-test in the experimental class group was significantly different from the average score on the pre-test and post-test in the control class group. The estimated intermediate learning outcomes score also significantly differed between the pre-test and post-test in the experimental class group. These findings indicate that the experimental learning model positively impacts learning outcomes compared to the control learning model. Therefore, the practical learning model has improved student outcomes regarding the outcomes learning variable compared to the control learning model. These findings strongly support the STAD Model's effectiveness in improving student achievement in this study.

Discussion

This research indicates that using the STAD Model significantly impacts students' learning outcomes and process skills. Descriptive data shows a significant increase in the average value of students' process skills and learning outcomes from before (pre-test) to after (post-test) following the learning, both in the control and experimental groups. In the experimental group, the average pre-test score was 65, while the average post-test score increased to 80, indicating a 23% increase. Conversely, in the control group, the average pre-test score was 63, and the average post-test score increased to 70, indicating an 11% increase. Prerequisite testing verifies that the data meets the required statistical assumptions, enabling parametric analysis methods. The results of hypothesis testing using MANOVA show an F-value of 15.68 (2, 97), $p < 0.001$, indicating a significant difference between the experimental and control groups regarding learning outcomes and process skills. The Test of Between-Subjects Effects confirms that the STAD model has a more positive influence than conventional learning models ($p < 0.001$). These findings underline the effectiveness of the STAD Model and provide a solid basis for considering its application in teaching.

Although the findings of this study show significant results, several potential confounding variables may have influenced the outcomes. Transparency in identifying and controlling these variables is essential to enhance the credibility of the findings. One such variable is the student's initial ability, which is controlled using a pre-test before the intervention. This way, we could ensure that the control and experimental groups had similar ability levels at the beginning of the study. Additionally, teacher involvement was a primary concern; all participating teachers received uniform training on implementing the STAD Model. Regular supervision and evaluation were conducted to ensure consistency in the application of the method. Student motivation was also a significant factor controlled through a learning motivation questionnaire administered before and after the intervention. It helped ensure that differences in learning outcomes were not due to variations in motivation between the control and experimental groups. Furthermore, the learning environment was kept similar, with the same physical conditions and facilities in all classes to reduce the influence of environmental variables. Finally, socioeconomic factors were controlled by collecting the students' demographic data, ensuring that no significant differences in socioeconomic backgrounds between the control and experimental groups could affect the study's outcomes.

The study results show that students participating in the STAD model experienced significant improvements in learning outcomes compared to those following traditional teaching methods. The average final test scores of the experimental group using STAD were higher than the control group, indicating that the STAD model effectively enhances student understanding and knowledge. The success of the STAD model in improving learning outcomes can be attributed to several factors. First, this model emphasizes group cooperation and discussion, encouraging students to participate and help each other understand the lesson material actively. Intensive social interaction in cooperative learning like STAD can enhance conceptual understanding through explanation and clarification among students. Second, individual accountability within STAD groups encourages students to learn independently and take responsibility for their learning. Additionally, students feel accountable for their learning, which leads to higher motivation and effort to achieve learning goals, which is evident in the increased final test scores of students in the experimental group.

These findings are consistent with previous research showing that the STAD model is efficacious in improving student learning outcomes across various subjects (Dewi et al., 2020; Hariyanto et al., 2023; Mahadi et al., 2023; Ngailo et al., 2021; Rahma et al., 2022). With this evidence, the STAD model is a practical learning approach for enhancing student academic achievement (Berzener & Deneme, 2021). Similarly, using STAD leads to a better understanding of science concepts (Z. Xu et al., 2023 (Xu et al., 2023). Therefore, the effectiveness of the STAD model in significantly improving student academic achievement has been proven. Increased interaction among students in learning groups creates an environment that allows mutual support and collaboration, ultimately enhancing material understanding and learning outcomes (Qureshi et al., 2023). This research confirms that STAD can be effectively applied in various educational contexts, including at SMP Muhammadiyah Ambon.

In addition to improving learning outcomes, this study also found that students' process skills in the experimental group improved significantly compared to the control group. The process skills measured included observation, classification, communication, and data interpretation. The improvement in process skills in the STAD group can be attributed to the model's structure, which emphasizes activity-based learning and group discussions. Students can observe, classify, and interpret data collaboratively, enhancing their ability to perform fundamental scientific processes. Cooperative learning, like STAD, allows students to develop process skills through active interaction and hands-on experience. Moreover, the facilitator role held by the teacher in the STAD model helps students stay focused and directed in learning activities, strengthening their process skill development. Teachers provide guidance and feedback to help students understand the steps and principles involved in various scientific processes.

These findings are in line with previous studies that show STAD implementation enhances students' collaborative and scientific process skills (Jamilah, 2021; Kamid, Syaiful, et al., 2022; Misbah et al., 2023; Rejeki, 2023; Sholehah, 2022; Sholikhah et al., 2019). Correspondingly, the STAD model has been shown to help improve students' critical and analytical thinking skills and demonstrate better capabilities in scientific process activities (Ishtiaq et al., 2019). The STAD model can develop students' collaborative abilities when working in teams (Tiantong & Teemuangsai, 2017). Using the STAD model can also enhance students' interpersonal communication skills as they work together in small groups to achieve common goals (Ibrahim & Adnan, 2019)—the critical role of the STAD model in boosting student self-confidence. Besides social and emotional aspects, the STAD model also influences students' metacognitive skills (Arjanggi & Setiowati, 2014). This model helps students become more aware of their learning processes, enabling them to effectively organize their learning strategies (Rad et al., 2023). The STAD model is vital for enhancing students' time and resource management skills by fostering collaboration, responsibility-sharing, and organizational skills, thus effectively preparing them for future challenges. (Nazari et al., 2021). The STAD model can increase student engagement and motivate them to learn (Afrikani et al., 2020). The STAD model effectively enhances students' process skills in learning activities by promoting teamwork, critical thinking, and problem-solving, leading to improved academic outcomes and practical skill development. (Takko et al., 2020). Thus, the STAD model has been proven to significantly impact students' process skills, making it an effective strategy to improve the quality of education in various contexts, including at SMP Muhammadiyah Ambon.

Although this study shows significant results in improving student learning outcomes and process skills through applying the STAD Cooperative Learning Model, there are some limitations to note. First, this study was conducted at a single school, SMP Muhammadiyah Ambon, so the generalization of its results may not be broadly applicable to other educational contexts. Variations in school conditions, learning cultures, and available resources can affect the effectiveness of the STAD model implementation. Second, implementing the STAD model requires adequate training and preparation for teachers. Teachers must understand and master group facilitation techniques and manage group dynamics that vary in student abilities and motivation. With adequate training, implementing the STAD model may be more optimal, and the expected results might be achieved. Third, infrastructural limitations, especially regarding access to technological devices, can hinder the optimal implementation of the STAD model.

In some cases, schools may need more resources to support the use of technology necessary for group-based learning activities. Additionally, diverse group dynamics regarding student abilities and motivation can challenge effective classroom management. Students with lower abilities may feel left behind or less confident, while students with higher abilities may feel under-challenged. Teachers need specific strategies to ensure each student actively participates and gains maximum benefit from this learning model.

Based on the findings of this study, there are several areas for further research to deepen the understanding of the effectiveness of the STAD Cooperative Learning Model. One crucial area is exploring the application of the STAD model in different educational contexts. Research can focus on schools in rural and urban areas to identify differences in the effectiveness of the STAD model. Additionally, schools with limited resources are also an important area to study. In environments with limited access to technology or learning facilities, research can explore how the STAD model can be implemented using available resources and still be effective. This research can also include an analysis of the long-term impact of the STAD model on students' academic development. Longitudinal studies tracking students' academic progress over several years after implementing the STAD model can provide insights into the model's sustained benefits on academic achievement and process skills.

Furthermore, future research can compare the effectiveness of the STAD model with other cooperative learning models, such as Jigsaw or Think-Pair-Share. Comparative research will help determine the most effective methods in specific contexts based on subjects or educational levels. For example, research can assess the effectiveness of the STAD model in various subjects such as science, language, or social studies and compare it with other cooperative models to identify the best approach for each subject. Additionally, it is essential to explore the impact of the STAD model on students' non-academic skills, such as social and emotional skills, self-confidence, empathy, and social problem-solving skills. Research at higher education levels is also exciting, focusing on how the STAD model can be adapted for college students and more complex learning contexts. Finally, integrating technology into the STAD model is a relevant research area, especially in online and hybrid learning, to identify the necessary adaptations to enhance the model's effectiveness in digital learning environments. Research exploring technological tools such as online collaborative platforms or learning software can provide practical guidance for integrating technology into the STAD model.

An example of a successful STAD model implementation can provide educators with concrete guidance. This model has been applied in a high school in Yogyakarta in mathematics, showing significant improvement in students' problem-solving skills and average math test scores (Misbah et al., 2023). Teachers organized students into heterogeneous groups, assigning specific roles based on individual abilities to ensure all members were actively involved and contributing (Tiantong & Teemuangsai, 2017). Challenges such as differences in student abilities and lack of engagement were successfully addressed with constructive feedback and rewards for groups showing significant improvement (Hariyanto et al., 2023). Additionally, challenges in managing group dynamics were addressed by providing teachers with training on effective facilitation techniques, enabling them to manage the classroom better and ensure each student maximizes the benefits of the STAD model (Ngailo et al., 2021). Other studies also support that the STAD model can improve students' interpersonal skills and self-confidence (Ibrahim & Adnan, 2019), emphasizing collaboration's importance in achieving better understanding (Sholikhah et al., 2019). Thus, implementing the STAD model has proven effective in enhancing student learning outcomes through structured and collaborative learning strategies while addressing various challenges through a comprehensive approach.

4. CONCLUSION

This research indicates that using the STAD Model significantly impacts students' learning outcomes and process skills. Descriptive data shows a significant increase in the average value of students' process skills and learning outcomes from before (pre-test) to after (post-test) following the learning, both in the control and experimental groups. In the experimental group, the average pre-test score was 65, while the average post-test score increased to 80, indicating a 23% increase. Conversely, in the control group, the average pre-test score was 63, and the average post-test score increased to 70, indicating an 11% increase. Prerequisite testing verifies that the data meets the required statistical assumptions, enabling parametric analysis methods. The results of hypothesis testing using MANOVA show an F-value of 15.68 (2, 97), $p < 0.001$, indicating a significant difference between the experimental and control groups regarding learning outcomes and process skills. The Test of Between-Subjects Effects confirms that the STAD model has a more positive influence than conventional learning models ($p < 0.001$). These findings underline the effectiveness of the STAD Model and provide a solid basis for considering its application in teaching. Future research should investigate the long-term effects of the STAD Model to understand its sustained impact on academic achievement and students' process skills, providing deeper insights into its effectiveness and potential areas for improvement. Additionally, studies on applying the STAD Model in various educational contexts, such as in rural or urban schools and across different subjects, can provide additional insights into the model's flexibility and effectiveness. Research can also focus on how integrating technology with the STAD Model can enhance learning outcomes and process skills in online or hybrid learning environments.

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