

Application of the STAD-type Cooperative Learning Model in Improving Natural Science Learning Outcomes

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ABSTRACT

This study aimed to improve the learning outcomes of fourth-grade students at State Elementary School 1 Singakerta in understanding the characteristics of light through the implementation of the STAD-type cooperative learning model. The research employed a Classroom Action Research (CAR) approach conducted in two cycles with 30 students as participants. Data were collected using tests, observations, and documentation and then analyzed descriptively using qualitative methods. The results revealed a significant improvement in student learning outcomes. The percentage of students achieving the Minimum Mastery Criteria (KKM) increased from 40% in the pre-cycle to 53% in Cycle I and reached 80% in Cycle II. Teacher activities improved from 70% (high category) in Cycle I to 87.5% (very high category) in Cycle II, while student engagement increased from 55% (high category) to 80% (very high category). These findings demonstrate that the STAD model enhances student learning outcomes and engagement in natural science classes. This study underscores the potential of cooperative learning models to address challenges in elementary science education, particularly in the context of the Fourth Industrial Revolution, by fostering active participation and collaborative skills among students.

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1. INTRODUCTION

Every country, including Indonesia, recognizes education's critical role in fostering its cultural heritage. Numerous laws and regulations in Indonesia have laid the groundwork for the country's educational system. Every Indonesian person has the right to education, as stated in Article 31 of the 1945 Constitution. Furthermore, the National Education System Law No. 20/2003 offers guidelines for executing education at all levels, beginning with basic education, and stresses the significance of universal access and the enhancement of educational quality for all students in Indonesia. These regulations are a foundation for

developing an inclusive and equitable educational framework for building a knowledgeable and skilled society.

In this age of the Fourth Industrial Revolution, among others, education in Indonesia faces new problems that have arisen alongside the times. Changes in education are among the many areas that will undoubtedly be affected by this revolution. Modern primary school curricula should equip pupils to think critically, creatively, collaboratively, and communicatively to succeed in the modern world [1], [2], [3]. However, achieving these goals requires a paradigm shift in teaching methodologies, integrating technology, and fostering innovative pedagogical approaches. Therefore, these challenges require learning that can integrate technology and interactive learning models. However, the reality is that many elementary schools still have not fully utilized technology and learning models following the demands of the Industrial Revolution [4], [5], [6]. This gap underscores the need for systemic reform to ensure that all schools meet contemporary educational standards.

Natural science is an important subject that equips elementary school students with basic knowledge about the natural environment and scientific phenomena around them. Good science learning teaches theory and encourages students to think critically and analytically and practice scientific concepts in everyday life [7], [8], [9]. However, in practice, many teachers still use conventional learning methods, such as lectures that are less effective in arousing students' interest and active participation, especially in science subjects. The lecture learning method often makes students passive in following lessons, making them less involved in the learning process. As a result, student learning outcomes tend to be low, especially in science subjects. This situation highlights the urgent need for a more dynamic and engaging approach to teaching science. This is a big challenge, given the importance of science subjects in forming a basic understanding of science and technology [10], [11], [12]. Consequently, there must be a shift in how primary school students learn, particularly in science classes, to encourage more active participation and better results.

The STAD cooperative learning paradigm is one avenue that might provide a solution to this problem. This strategy emphasizes students working together in small groups to accomplish common goals. Students are more engaged and get better class results using a cooperative learning paradigm like STAD [13]. Moreover, this method aligns well with the principles of active learning, which encourage students to take responsibility for their learning and collaborate effectively with peers. Students may hone their social and cognitive abilities via collaborative learning activities emphasizing group work and debate [14], [15], [16], [17]. These skills are critical for academic success and navigating the complexities of the modern workforce.

In line with this, the 2022 PISA results revealed a concerning trend: the average performance of Indonesian students in mathematics, reading, and science ranked among the lowest ever recorded, matching levels from 2003 in reading and mathematics and 2006 in science. The percentage of students scoring below the baseline proficiency level (Level 2) has significantly increased since 2012, especially in reading (by 19 percentage points) and mathematics (by five percentage points). Alarmingly, almost no Indonesian students

achieved the highest proficiency levels (Level 5 or 6) in science, compared to the OECD average of 7%, highlighting gaps in critical thinking and problem-solving abilities [18], [19]. These findings point to systemic issues that must be addressed at policy and classroom levels to improve Indonesia's global educational standing.

This national performance resonates with classroom challenges observed at SDN I Singakerta, where fourth-grade students exhibit low interest in learning science. The teacher-centered approach predominantly relies on lectures and unengaging practices, leading to poor comprehension and limited student participation. Studies like Noviana [20] address such challenges and demonstrate that innovative methods, such as the Cooperative Learning Model STAD (Student Teams Achievement Division), significantly enhance student learning outcomes. For instance, Noviana reported a 16.95-point improvement in average scores between the baseline and the first learning cycle and consistent progress through subsequent cycles [20]. These results illustrate the potential of cooperative learning models to transform classroom dynamics and improve learning outcomes significantly. These findings suggest that adopting interactive and student-centred strategies like STAD could improve individual performance and bridge broader educational gaps in national assessments like PISA.

This study aims to evaluate the impact of implementing the STAD Cooperative Learning model on science education in the fourth grade at SDN I Singakerta. The research focuses on three primary objectives: understanding the practical application of the STAD model in classroom settings, analyzing student engagement during its implementation, and assessing the learning outcomes achieved. The study seeks to provide actionable insights into improving elementary school teaching practices and student learning experiences by addressing these objectives. By incorporating an interactive and student-centred approach, the study aligns with the educational demands of the Fourth Industrial Revolution, where fostering critical thinking and collaborative skills is paramount. Ultimately, this research aspires to contribute to broader educational reforms that enhance local classroom practices and Indonesia's performance on global benchmarks like PISA.

2. METHOD

This study employed Classroom Action Research (CAR) based on the Kemmis and McTaggart model, which includes planning, action, observation, and reflection in iterative cycles [21]. This approach is particularly suitable for addressing specific classroom challenges and testing the effectiveness of teaching strategies in real-time. CAR is a research approach that seeks to enhance learning methods directly in the classroom [22], [23]. The study was conducted in two cycles with 30 fourth-grade students at State Elementary School 1 Singakerta as participants. These students were selected purposively to ensure representation of various academic backgrounds, particularly in science. The students ranged in age from 9 to 10 years and had varying levels of prior academic achievement in science.

Data Collection Instruments

Data were collected using:

1. **Observation Sheets:** Researchers kept detailed notes on students' learning activities using observation sheets. Teacher activities (e.g., explaining materials, guiding group discussions) and student engagement (e.g., participation in group tasks, asking and answering questions) during the implementation of the STAD Type Cooperative learning model were recorded in detail for further analysis. The observation aimed to capture qualitative and quantitative aspects of classroom interactions, providing comprehensive insights into teaching and learning dynamics.
2. **Tests:** Comprising 10 multiple-choice and five essay questions covering the topic of light properties, validated by science education experts. The validation process ensured the reliability and validity of the test items as a measure of students' understanding. This test aims to determine students' understanding of the science material studied and measure how much learning outcomes have improved after implementing the STAD learning model. The tests were administered at three stages: pre-cycle, Cycle I, and Cycle II, allowing for a clear comparison of learning progress.
3. **Documentation:** Documentation data in the form of photographs and notes of classroom activities during the implementation of the STAD model. This documentation aims to strengthen observation results with visual evidence regarding student activities using the STAD cooperative learning model. Additionally, these visual records served as supplementary data to validate the findings obtained from observations and tests.

Data Analysis

Data were analyzed using descriptive qualitative methods [24]. Observation results were categorized based on frequency and level of engagement, while test scores were averaged and compared across pre-cycle, Cycle I, and Cycle II. This analytical approach facilitated a detailed examination of student participation and performance trends. Success criteria were set at 80% of students achieving scores above the Minimum Mastery Criteria (KKM) of 70, determined based on school standards. This benchmark reflects the minimum level of competency required for students to demonstrate adequate mastery of the material. This achievement shows that applying the STAD model can improve student learning outcomes and activity during the learning process. The findings are expected to provide empirical evidence supporting the effectiveness of cooperative learning models in enhancing primary school science education.

3. RESULTS AND DISCUSSION

RESULTS

3.1. Teacher Activity

One of the key factors that may evaluate the efficacy of the learning process implementation is the level of teacher participation in learning. Data collecting tools utilized in implementing the STAD-type Cooperative learning model include observation sheets and documentation, which allow for an accurate evaluation of teachers' actions. The

findings of the observations of the teachers' activities in cycle I are shown in Table 1 below.

Table 1. Recapitulation of Teacher Activity Observation Results from Cycle I

No.	Aspects observed	Value			
		4	3	2	1
1.	Deliver essential competencies and learning objectives.		√		
2.	Provide appreciation to students related to the material and the properties of light in the STAD-type <i>Cooperative Learning</i> activity.	√			
3.	Give clear instructions regarding today's learning rules before the start of the activity.		√		
4.	Guide students to form several groups.		√		
5.	Guide each group of students according to the STAD-type cooperative learning activity material.		√		
6.	Ensure that students get used to doing STAD-type <i>cooperative learning</i> activities.				√
7.	Provide feedback on practice questions about today's learning material.		√		
8.	Checking student activity sheets related to today's lesson material.				√
9.	After the learning process is complete, the teacher gives assertiveness about the learning material in the STAD-type <i>cooperative learning</i> activity.				√
10.	The teacher motivates students to learn.		√		
	Total	4	18	6	0
	Total		28		
	Percentage		70%		
	Criteria		High		

According to Table 1, the first cycle of activities observed by teachers in science classes using the STAD cooperative learning model yielded a score of 28 out of 40 (or 70%), placing them in the high category. This model was used to teach students about the properties of light. Unfortunately, the results have fallen short of the 80% success criteria because teachers are unprepared to use this learning paradigm. Consequently, the STAD-type cooperative learning model requires meticulous planning to be effective, including creating a set of questions, a set of answer keys, and guidelines for the various learning activities [25], [26], [27], [28].

In addition, the teacher's preparation in understanding and delivering the material interactively is also an important factor in achieving the effectiveness of the STAD cooperative learning model. This is because the STAD-type cooperative model is one of the cooperative learning techniques that requires systematic planning to involve students in learning optimally.

Table 2. Recapitulation of Teacher Activity Observation Results from Cycle II

No.	Aspects observed	Value			
		4	3	2	1
1.	Deliver essential competencies and learning objectives.		√		
2.	Provide appreciation to students related to the material and the properties of light in the STAD-type <i>Cooperative Learning</i> activity.	√			
3.	Give clear instructions regarding today's learning rules before the start of the activity.	√			
4.	Guide students to form several groups.	√			
5.	Guide each group of students according to the STAD-type cooperative learning activity material.		√		
6.	Ensure that students get used to doing STAD-type <i>cooperative learning</i> activities.	√			
7.	Provide feedback on practice questions about today's learning material.	√			
8.	Checking student activity sheets related to today's lesson material.		√		
9.	After the learning process is complete, the teacher gives assertiveness about the learning material in the STAD-type <i>cooperative learning</i> activity.		√		
10.	The teacher motivates students to learn.		√		
	Total	20	15		
	Total		35		
	Percentage		87,5%		
	Category		Very High		

Based on Table 2, it is obtained that there is an increase in the observation score of teacher activity to 35 out of a total of 40 with a percentage of 87.5%, which is categorized as very high. According to these data, the research has achieved a success indication of 80%. Teachers were much more active in cycle II's STAD-type cooperative learning model implementation due to adopting assessments and adjustments based on cycle I's findings. Consistent with what Joyce et al. have said, the learning process's continuous improvement cycle may aid educators in spotting methodological flaws and making better-informed corrections.

3.2. Student Activity

The effectiveness of learning is highly correlated with the degree to which students actively participate in it. The outcomes of the first cycle's worth of student activity observations are shown in Table 3.

According to Table 3, the first cycle's observation score for student activity was 22 out of 40, or 55%, which is considered high. Cycle I student activity was subpar, and students' unfamiliarity with the STAD learning approach from class IV State Elementary School I Singakerta was a contributing factor. Students struggling to grasp freshly introduced concepts or instructional strategies may lead to low levels of student engagement.

Table 3. Recapitulation of Student Activity Observation Results from Cycle I

No.	Student Learning Activity	Assessment			
		1	2	3	4
1.	Student readiness for learning.		√		
2.	Listening to the teacher's explanation				√
3.	Ability to master the material.			√	
4.	Students' courage in asking questions.		√		
5.	Students' courage in answering.		√		
6.	Student engagement in group activities.	√			
7.	Students' courage in presenting in class.		√		
8.	Students' courage in expressing their opinions		√		
9.	Cooperation in group activities.		√		
10.	Student responsibility in doing assignments.		√		
	Total	1	14	3	4
	Total		22		
	Percentage		55%		
	Criteria		High		

A key predictor of meaningful learning that impacts student learning outcomes is student engagement in the learning process. Students actively participating in their learning are more likely to retain the information. The STAD-type cooperative learning model stands out among the many learning models that impact student engagement.

Table 4. Recapitulation of Student Activity Observation Results from Cycle II

No.	Student Learning Activity	Assessment			
		1	2	3	4
1.	Student readiness for learning.				√
2.	Listening to the teacher's explanation				√
3.	Ability to master the material.			√	
4.	Students' courage in asking questions.		√		
5.	Students' courage in answering.				√
6.	Student engagement in group activities.			√	
7.	Students' courage in presenting in class.		√		
8.	Students' courage in expressing their opinions			√	
9.	Cooperation in group activities.			√	
10.	Student responsibility in doing assignments.				√
	Total		4	12	16
	Total		32		
	Percentage		80%		
	Criteria		Very High		

A score of 32 out of 40 (indicating 80% and in the very high category) indicates that student activity in cycle II grew considerably, according to Table 4. Suryanti contended that the STAD learning paradigm may enhance student engagement and learning results, and this growth is consistent with her claims. After evaluating Cycle I, the instructor improved their preparation and execution of STAD, which contributed to its practical implementation in Cycle II. Students have more chances to engage and contribute to class discussions and activities using the STAD model, which has them work in small

groups. This uptick in activity shows that the STAD approach effectively engages students in what they are studying, improving their performance in class.

3.3 Student Learning Outcomes

Applying the STAD paradigm to scientific courses improves students' content comprehension, as shown by improved learning outcomes. Assuming that 80% of students get KKM-level scores, we can say they have completed the learning process. In fourth grade at State Elementary School 1 Singakerta, the KKM for science is 70. Results from pre-cycle science classes on light characteristics are shown in Table 5 below.

Table 5. Recapitulation of Pre-Cycle Student Learning Outcomes

Completed	12 students	40%
Not Completed	18 students	60%
Highest Score	90	
Lowest Score	20	
Average	57,7	

From the data in the table above, we can deduce that out of the total number of students in the pre-cycle stage, only 12 (or 40%) finished the learning process with an average score of 57.7. Meanwhile, as many as 18 other students were declared not to have completed learning with a percentage of 60%. These results are still far from the success indicator set; as many as 80% of students can achieve scores above the KKM.

Table 6. Recapitulation of Student Learning Outcomes Cycle I

Completed	16 students	53%
Not Completed	14 students	47%
Highest Score	100	
Lowest Score	30	
Average	65,0	

Table 6 indicates that students' average scores went up to 65.0, and the number of students who finished learning went up to 16 (a 53% increase) when the STAD model was used in cycle I. Even still, fourteen more students (or 47% of the total) were found to have failed to finish the course of study. Nonetheless, the standard success indicator was still not satisfied by this outcome. Students can get a more thorough grasp of course content because of the emphasis on student-to-student communication and collaboration in the STAD-type cooperative learning paradigm.

Table 7. Recapitulation of Student Learning Outcomes Cycle II

Completed	24 students	80%
Not Completed	6 students	20%
Highest Score	100	
Lowest Score	50	
Average	75,0	

Table 7 shows that students' learning outcomes in cycle II improved significantly compared to cycle I. Of the 30 students, 24 were declared to have completed learning, with a percentage of 80%, and had an average score of 75.0. On the other hand, only six pupils, or twenty per cent, did not finish the course. The STAD approach improves student learning outcomes in a classical sense, as seen by this rise. Furthermore, cooperative learning models may enhance student engagement and content comprehension via group discussion exercises to outperform traditional learning models.

DISCUSSION

The results of this study indicate that implementing the STAD cooperative learning model significantly enhances student engagement and learning outcomes in science education for fourth-grade students at SD Negeri 1 Singakerta. This finding aligns with the study by Noviana [20], which revealed that the STAD model improved students' average scores by 16.95 points from the baseline to the first cycle, with consistent progress in subsequent cycles. Similarly, Purnawan et al. [26] found that cooperative learning models effectively increase student engagement, particularly in subjects requiring a deep understanding of concepts, such as science. These findings reinforce the notion that the STAD model positively impacts active student participation and learning outcomes, particularly in understanding the properties of light.

The increase in student activity during STAD-based learning also aligns with active learning theories emphasizing the importance of collaboration and direct involvement in the learning process. Johnson [29] stated that group-based learning allows students to learn from social interactions, enhances critical thinking skills, and strengthens concept comprehension. This study provides empirical evidence that active student engagement in small groups improves conceptual understanding and fosters social skills relevant to 21st-century competencies.

However, this study also highlights several challenges, particularly in the first cycle, where the observed teacher and student activities did not reach optimal levels. This may be due to students' initial lack of familiarity with the STAD cooperative learning approach. These findings are consistent with Desnita et al. [25], who noted that students often experience confusion when first introduced to new learning models. Therefore, teachers must provide more detailed guidance and prepare students gradually before adopting innovative teaching approaches.

Another limitation of this study is the scale of its application. The research involved only 30 students from a single school, which may limit the generalizability of its findings. Additionally, the evaluation of learning outcomes was conducted over just two cycles, which might not entirely reflect the long-term effects of the STAD model. The learning outcomes assessment relied solely on written tests, thereby excluding a deeper examination of students' science process skills.

For future research, it is recommended that the scope be broadened by involving more schools and students from diverse backgrounds. Studies should also consider longer implementation durations to measure the long-term impact of the STAD model. Moreover, employing more diverse evaluation methods, such as in-depth observations or project-

based assessments, could provide a more comprehensive understanding of the model's effects on various aspects of student learning. Researchers could also explore integrating the STAD model with digital technology to further enhance its effectiveness, particularly in the era of the Fourth Industrial Revolution.

4. CONCLUSION

The teacher activity observation data analysis shows that fourth graders at State Elementary School I Singakerta in Krangkeng District, Indramayu Regency, can benefit from implementing the STAD-type cooperative learning model into their science classes. This conclusion is supported by the discussion and results presented above; in cycle I, the teacher activities scored 28 out of a possible 40, or 70%, which is considered a high criterion. Next, it improved in cycle II, reaching 87.5% (35 out of 40) and earning a spot in the very high criterion. This indicates that teacher readiness and involvement improved significantly across cycles, contributing positively to the learning process.

The level of student activity also rose with each cycle; in the first, it was 22 out of 40, or 55% of the total, meeting the high criterion. In the second, 32 out of 40 met the high criterion, or 80%. This demonstrates that the STAD model fosters student engagement, emphasizing collaboration and group-based learning activities.

In addition, the STAD-type cooperative learning approach significantly improved the learning results of fourth graders at State Elementary School 1 Singakerta in science classes. With an average score of 57.7 in the pre-cycle, only 12 out of 30 students were determined to have finished learning, indicating that just 40% met the Minimum Mastery Criteria (KKM). The percentage rose to 53% in cycle I, with an average score of 65.0; this meant that 16 out of 30 pupils were deemed to have finished studying. Afterwards, in cycle II, it rose to 80% with an average score of 75.0, indicating that 24 out of 30 students had completed learning. These findings highlight the potential of the STAD model in addressing challenges related to low student performance and engagement in science education.

Implementing the STAD cooperative learning model has proven an effective strategy for improving teacher and student activities and learning outcomes in science classes. However, the study was limited in scale and duration, suggesting the need for further research to confirm these findings in broader and more diverse settings.

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