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The application of the STAD cooperative learning model to improve Math learning outcomes

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ABSTRACT

This study aims to improve mathematics learning outcomes on diagram topics for second-grade students by applying the cooperative learning model, specifically the STAD (Student Teams Achievement Divisions) approach. Initial observations revealed that the teaching methods were ineffective, with low student participation and limited understanding of the material. This research employed a classroom action research approach with two cycles. In the first cycle, the implementation of the STAD model resulted in an average success rate of 63.39 percent, which was considered inadequate. In the second cycle, improvements were made by introducing more interactive and engaging teaching media. These improvements led to a significant increase in the success rate, reaching an average of 87.4 percent. The study demonstrates that applying the STAD model significantly enhanced students' learning outcomes and engagement in the learning process. However, some students still required additional support to achieve mastery. This study highlights the importance of continuous evaluation and adaptation of teaching methods to meet individual student needs, ensuring that learning objectives are optimally achieved.

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ABSTRAK

Penelitian ini bertujuan untuk meningkatkan hasil belajar matematika pada materi diagram siswa kelas II melalui penerapan model pembelajaran kooperatif tipe STAD (Student Teams Achievement Divisions). Observasi awal menunjukkan bahwa metode pembelajaran yang digunakan kurang efektif, dengan partisipasi siswa yang rendah serta pemahaman yang terbatas terhadap materi. Penelitian ini menggunakan pendekatan tindakan kelas dengan dua siklus. Pada siklus pertama, penerapan model STAD menghasilkan rata-rata tingkat keberhasilan sebesar 63,39 persen, yang dianggap belum memadai. Pada siklus kedua, dilakukan perbaikan dengan memperkenalkan media pembelajaran yang lebih interaktif dan menarik. Hasil dari perbaikan ini menghasilkan peningkatan signifikan, dengan rata-rata tingkat keberhasilan mencapai 87,4 persen. Penelitian ini membuktikan bahwa penerapan model pembelajaran STAD secara signifikan mampu meningkatkan hasil belajar siswa serta keterlibatan mereka dalam proses pembelajaran. Meskipun demikian, terdapat beberapa siswa yang masih membutuhkan perhatian dan bimbingan tambahan untuk mencapai ketuntasan. Penelitian ini menekankan pentingnya melakukan evaluasi berkelanjutan dan menyesuaikan metode pembelajaran agar sesuai dengan kebutuhan individu siswa, sehingga tujuan pembelajaran dapat tercapai dengan optimal.

Kata Kunci: *pembelajaran kooperatif; hasil pembelajaran; matematika; STAD*

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INTRODUCTION

Education plays an important role in ensuring the survival of the nation and state, as well as in developing the quality of human resources. Realizing a high-quality society is the responsibility of education, particularly the responsibility of education to prepare students to increasingly demonstrate their independence, creativity, and innovation. This is in line with the objectives of national education as stated in Undang-Undang Republik Indonesia Nomor 20 Tahun 2003 tentang Sistem Pendidikan Nasional in Bab 11 Pasal 3, which explains that "Pendidikan nasional berfungsi mengembangkan kemampuan dan membentuk watak serta peradaban bangsa yang bermartabat dalam rangka mencerdaskan kehidupan bangsa, bertujuan untuk berkembangnya potensi peserta didik agar menjadi Manusia yang beriman dan bertakwa kepada Tuhan Yang Maha Esa, berakhlak mulia sehat, berilmu, cakap, kreatif, mandiri dan menjadi warga negara yang demokratis serta bertanggung jawab. (National education serves to develop abilities and shape the character and civilization of a dignified nation in order to educate the nation, with the aim of developing the potential of students to become people who believe in and fear God Almighty, have noble character, are healthy, knowledgeable, skilled, creative, independent, and become democratic and responsible citizens)".

To achieve these educational goals, different plans and processes must be implemented, including the learning process. The learning process is essentially an integrated and comprehensive activity between students and educators in a classroom setting. Learning is the assistance provided by educators to facilitate the process of acquiring knowledge, mastery, skills, and habits, as well as shaping the attitudes and beliefs of students (Letina, 2020; Wahono & Chang, 2019). The learning process can run smoothly, one way being to select various learning models that cater to the needs of students in the classroom (Dakhi *et al*., 2020; Mandasari & Wahyudin, 2021). A learning model is a method used to implement a plan that has been prepared to achieve learning objectives. One of the various existing learning models is the cooperative learning model.

Cooperative learning is a learning strategy that involves students working collaboratively to achieve common goals. Cooperative learning is designed to increase student participation, facilitate leadership experiences and decision-making in groups, and provide opportunities for students to interact and learn together with those from different backgrounds (Hasanah & Himami, 2021). Cooperative learning is a form of active learning that emphasizes group activities over individual ones (Atikah *et al*., 2024). Students work in groups to develop life skills such as problem-solving, decision-making, logical thinking, effective communication, and cooperation.

Student Teams Achievement Divisions (STAD) is a cooperative learning model designed to increase student participation and learning outcomes through teamwork. Developed by Robert Slavin and his colleagues, STAD emphasizes dividing students into small, heterogeneous groups, where each group member has a responsibility to help one another understand the subject matter (Takko *et al*., 2020). STAD consists of five main steps: presentation of material by the educator, group work, individual quizzes, score improvement, and group rewards (Desnita *et al*., 2021; Fika, 2020). During the group work stage, students collaborate to complete the assigned tasks or exercises, and each group member is expected to contribute according to their abilities. After that, students take an individual quiz to test their understanding of the material they have learned. These individual scores are then compared to their previous scores, and the group that shows the best improvement is rewarded.

The advantage of the STAD model lies in its ability to encourage collaboration and shared responsibility among students. By focusing on individual improvement, which is then rewarded as a group achievement, the STAD model integrates healthy competition in the classroom while still emphasizing the importance of teamwork (Don & Arumugam, 2019; Liu *et al*., 2020). Research indicates that STAD is not only effective

in enhancing academic understanding but also in increasing student motivation and engagement, particularly in subjects such as mathematics and science (Ibrahim & Adnan, 2019). Additionally, STAD can enhance social skills, including communication, cooperation, and empathy, as students are encouraged to assist one another in understanding the subject matter (Ghufron, 2023). The STAD model is also flexible and can be applied to various subjects and levels of education, making it one of the most frequently used learning strategies in modern education (Dejene & Chen, 2019).

Based on the results of the observations conducted, it appears that learning among second-grade students has not been effective. The results of the observations indicate that when learning mathematics material through diagrams, students appear to have a limited understanding of the material. During the learning process, students only look, listen, and take notes on the teacher's explanations. Thus, the learning activities are primarily carried out by the teacher, who explains the material, provides example questions, and then assigns students to complete practice questions. Student involvement in learning was significantly reduced. Students seemed reluctant to ask the teacher questions when they encountered problems they did not understand, and they were also rarely willing to discuss these issues with their friends. This learning process indeed resulted in low learning outcomes for second-grade students in mathematics diagram material.

To improve this situation, the researcher will apply a learning model in the second grade that has the following characteristics: a learning model that can actively involve students in the learning process; a learning model that can build communicative interactions between students and between students and educators; a learning model that allows students to help and share; and cooperate in completing tasks given by the educator, as well as a learning model that allows students to work on problems both individually and in groups. Of the various existing learning models, one of the selected learning models is the STAD type of cooperative learning model.

LITERATURE REVIEW

STAD in Mathematics Learning

In relation to this learning model, a learning approach that can be introduced to students is the STAD type of cooperative learning. STAD is one of the simplest cooperative learning models for educators who are new to the cooperative approach (Fika, 2020). STAD cooperative learning is a type of learning model that uses small groups of 4-5 heterogeneous students (Ghufron, 2023). In addition, the STAD model emphasizes group cooperation, where students learn together in small teams to understand the subject matter, thereby creating a more interactive and engaging learning atmosphere (Berlyana & Purwaningsih, 2019; Yaduvanshi & Singh, 2019). The STAD learning model also enables students to support one another and enhance their understanding of the material being taught, thereby improving their learning outcomes. By implementing STAD-type cooperative learning, students can become actively engaged and motivated to find solutions to problems and communicate their knowledge to their peers, thereby gaining a deeper understanding of the material (Kondang *et al*., 2022).

STAD cooperative learning can be implemented in various subjects, including mathematics in elementary school. In an effort to create a competent generation, mathematics learning is one of the most essential subjects because mathematical ability is the basis for the development of logical and analytical thinking skills. Mathematics is an effort by students to apply the knowledge they have learned in arithmetic. One of the materials in second-grade mathematics is about diagrams (Hardianti *et al*., 2023; Rizkia *et al*., 2024). Additionally, learning mathematics can be unenjoyable for some students, which can lead to lower learning outcomes. This is because the presentation of mathematics learning material on diagrams is only focused on student books and does not use media. As a result, students quickly become bored and tired in class, leading to ineffective and suboptimal learning outcomes. In reality, many students struggle to understand

mathematical concepts, resulting in lower learning outcomes. These low learning outcomes are often caused by ineffective learning methods that tend to be dominated by a conventional approach, where the educator is the center of learning and students tend to be passive (Qomario *et al*., 2020).

Constructivism

Constructivism is one of the most influential approaches to learning in education, developed by psychologists such as Jean Piaget and Lev Vygotsky. This theory emphasizes that knowledge is actively constructed by individuals through interaction with their environment (Makewa, 2019). In the constructivist view, learners are not passive recipients of information; instead, they are active agents who form new knowledge based on their experiences and existing schemas. Piaget stated that children learn through a process of assimilation and accommodation, in which they absorb new information into their existing knowledge framework (assimilation) or modify their schemas to accommodate new experiences (accommodation). Effective learning, according to constructivism, occurs when learners engage in challenging tasks that are relevant to their lives, encouraging them to rethink and modify their understanding (Saleem *et al*., 2021; Shah, 2019).

Constructivism also recognizes the importance of social context in learning. Lev Vygotsky, a leading figure in social constructivist theory, emphasized that learning occurs most effectively through social interactions, where learners can collaborate and learn from one another. Vygotsky's concept of the zone of proximal development (ZPD) describes the distance between what learners can achieve independently and what they can achieve with the help of others, such as educators or peers (Xi & Lantolf, 2021). In this case, the support provided by others is referred to as scaffolding, which helps learners develop a deeper understanding of the material. In educational practice, constructivism requires educators to not only provide information directly but also to create an environment that allows students to explore, ask questions, and solve problems independently. In contrast, educators act as facilitators who support the process (Poehner *et al*., 2019).

Learning Outcomes

Learning outcomes are descriptions of what learners should know, understand, and be able to do after completing a learning process. Learning outcomes focus not only on cognitive aspects, but also on the affective domain (values, attitudes, and feelings) and psychomotor domain (motor skills) (Gunawan *et al*., 2023). This theory emphasizes the importance of clear objectives in the learning process, in which educators design appropriate learning activities to achieve these outcomes. One of the most commonly used models in formulating learning outcomes is Bloom's Taxonomy, which divides learning outcomes into six cognitive levels: knowledge, comprehension, application, analysis, synthesis, and evaluation (Momen *et al*., 2023; Ullah *et al*., 2020). With this taxonomy, educators can ensure that the learning process does not only revolve around memorizing information, but also around developing critical thinking and problem-solving skills (Nusantari *et al*., 2021).

Learning outcomes are significant because they help direct the focus of learning and provide an evaluation framework for educators and learners. Learning outcomes serve as a guide for planning relevant learning activities and assessments (Wei *et al*., 2021). For example, suppose one of the expected learning outcomes is the ability of learners to solve mathematical problems. In that case, educators must design tasks that not only teach basic concepts but also provide opportunities for learners to apply those concepts. In addition, learning outcomes also provide a measuring tool for learners to understand their achievements in the learning process (Wallace *et al*., 2021). Clear learning outcomes can evaluate learner performance and identify areas that require further development (Wallace *et al*., 2021). Learning outcomes, thus, serve as a compass that ensures that all learning activities lead to the desired educational goals.

METHODS

This study uses a classroom action research approach. Classroom action research is conducted to improve the learning process, involving a repetitive cycle consisting of planning, implementation of actions, observation, and reflection. In each cycle, educators identify problems or specific aspects of the learning process that require improvement, design and implement targeted actions, and assess the impact of these actions on student learning.

The subjects of this study were 30 second-grade students at an elementary school. The instruments used to measure learning outcomes were end-of-cycle tests that assessed students' understanding of the material taught, as well as observation sheets that recorded students' activities during the learning process. The combination of tests and observations provided a comprehensive picture of the improvement in learning outcomes and student engagement.

The analysis of learning outcome success in each cycle of this study was conducted using the following assessment.

$$Score = \frac{Score\ obtained}{Maximum\ score}\ x\ 100\%$$

The interpretation of the criteria for successful learning improvement, as outlined by Santi (2022), is also presented in **Table 1** below.

Table 1. Criteria for Successful Improvement in Learning Outcomes

Interval	Criteria
85-100	Very good
75-84	Good
65-74	Enough
<65	Poor

Source: Author's research, 2024

Research Procedures

Cycle I

This study employed classroom action research, conducted in two cycles. In the planning stage, a lesson plan was developed using the STAD cooperative learning model. This plan included determining the material to be taught, forming study groups, preparing student worksheets, and developing evaluation instruments to be used at the end of each cycle. The implementation stage was carried out according to the plan that had been developed. At this stage, the STAD cooperative learning model was applied in the mathematics learning process. Each meeting began with the educator greeting the students, taking attendance, asking about the students' well-being, conveying the learning objectives for the day, presenting the material, grouping the students into several groups of 4-5 students with heterogeneous abilities, distributing group worksheets, completing group worksheets, group representatives presenting in front of the class, other group members and the educator providing feedback, drawing conclusions, the educator and students reflecting, and the educator conducting an evaluation test at the end of the session. Each group strives to achieve the best results because their work will be assessed and contribute to the individual scores of group members.

Observations were carried out continuously during the implementation stage. The process of observing student activities during the learning process, especially the interactions between students in groups, their participation in discussions, and their level of understanding of the material taught. These observational

data were used to assess the effectiveness of the STAD model and identify aspects that needed improvement in the next cycle. An evaluation is conducted to determine the students' absorption and mastery of the material, so at the end of the first cycle meeting, students are given a test. Finally, the reflection stage is conducted after all data from the observation and the final test results of the cycle have been collected. At this stage, the learning outcomes are analyzed, and the strengths and weaknesses of the STAD model implementation are identified. The results of the reflection are used to develop an improvement plan for the next cycle, ensuring that learning in the second cycle is more effective. The shortcomings identified in Cycle I are taken into consideration when determining the actions to be taken in Cycle II.

Cycle II

In cycle II, the actions taken were improvements and developments from cycle I. The stages were similar to those in the previous cycle, spanning from planning to implementation. However, there was a significant difference in the selection of learning media used. In this cycle, educators introduced more interesting and interactive media to increase student motivation and engagement. The learning process began with an introduction from the educator, followed by grouping the students into small groups. Students then work on assignments using the new media that have been prepared. The use of more varied media is expected to improve students' understanding of the material being taught. Observation and evaluation are conducted continuously to assess the effectiveness of the actions taken and to provide data for reflection at the end of the cycle, ensuring overall improvement in student learning outcomes.

RESULTS AND DISCUSSION

Cycle I

Cycle I was conducted on Monday, May 21, 2024. The material provided in Cycle One included various diagrams that discussed torus diagrams and pictures. After conducting a test at the end of the lesson, the mathematics learning outcomes of grade 2 students were obtained as listed in **Table 2** below.

Table 2. Mathematics Learning Outcomes in Cycle I

No	Description	Details
1	Highest score	17
2	Lowest score	13
3	Number of students who have completed	17
4	The number of students who have not completed	13
5	Score total	1775
6	Percentage of average learning success scores	63,39%

Source: Author's research, 2024

Based on **Table 2**, the learning outcomes achieved by second-grade students in Cycle I are evident. The total score was 1775 with an average learning success rate of 63.39%. Of the 30 students, 13 did not complete the cycle. Because the success indicators were not met, the study continued to cycle II. Based on the average percentage of learning success, the results are still classified as low.

In Cycle I, the learning outcomes of second-grade students in mathematics indicate that although 17 students achieved mastery, 13 students still did not. This indicates that around 43.33% of the total students had not achieved the set success standard. The highest score obtained by students was 17, while the lowest was 13, with a total overall score of 1775. The average success rate of 63.39% indicates that, in general, mathematics learning outcomes in Cycle I are still relatively low and do not meet the learning success indicators. In STAD-type cooperative learning, these suboptimal results may be attributed to a

lack of effective collaboration between groups or inadequate individual understanding of the material taught (Silva *et al*., 2021).

Since the average success rate remains below the expected standard, improvements are needed in Cycle II. These improvement measures may include strengthening the material, adjusting the learning strategy, and providing more intensive guidance to students who have not yet completed the course. In Cycle II, it is hoped that the better implementation of the STAD learning model, with more optimal group division and constructive feedback, will help improve students' understanding of mathematical concepts. Research in Cycle II will focus on overcoming the obstacles encountered in Cycle I and ensuring that students achieve better learning outcomes, thereby enabling all students to meet the specified completion criteria.

Cycle II

Cycle II was conducted on Tuesday, June 4, 2024. The material provided included various diagrams and pictures discussing tree diagrams. After conducting a test at the end of the lesson, the learning outcomes of Grade 2 students in Cycle II were obtained, as listed in **Table 3** below.

Table 3. Mathematics Learning Outcomes in Cycle II

No	Description	Details
1	Highest score	25
2	Lowest score	5
3	Number of students who have completed	25
4	The number of students who have not completed	5
5	Score total	2360
6	Percentage of average learning success scores	87,40%

Source: Author's research, 2024

Based on **Table 3**, it can be seen that the learning outcomes obtained by second-grade students had an average score of 87.40. Of the 30 students, five did not complete the learning process. These students who did not complete the learning process were examined in terms of their reading and arithmetic abilities, which were indeed lacking in the learning process. Based on the average score percentage criteria, the learning outcomes were still classified as excellent. Considering that the success indicators had been met, this study was terminated and not continued to the next cycle.

In Cycle II, the learning outcomes of grade 2 students showed a significant increase compared to Cycle I. Based on **Table 3**, the highest score achieved was 25, and the lowest was 5. The number of students who achieved mastery increased to 25, while only five remained uncompleted. This indicates that around 83.33% of students have achieved the minimum mastery criteria, suggesting a substantial improvement in students' understanding of the material taught, specifically regarding turus diagrams and pictures. Additionally, the total number of points obtained by students increased to 2,360, with an average learning success rate of 87.40%. This indicates that most students have a good understanding of the material, as expected.

Although five students have not yet completed the course, further analysis reveals that the primary obstacle they face is a lack of basic reading and arithmetic skills. This obstacle is not entirely related to their understanding of the mathematics material provided, but rather to their basic literacy skills, which affect their overall performance. However, with an average success rate of 87.40%, the success indicators set in this study have been met. Therefore, the study was not continued to the next cycle, as the improvement in learning outcomes in Cycle II was considered sufficient to achieve the expected learning objectives. The effectiveness of applying the STAD cooperative learning model in helping students understand the material (Yaduvanshi & Singh, 2019).

Discussion

This classroom action research was conducted in two cycles. The results of the research conducted in these two cycles showed a significant increase in the mathematics learning outcomes of second-grade students. In Cycle I, which was conducted on May 21, 2024, the average percentage of learning success was 63.39%, which was still considered unsatisfactory. Of the 30 students, 17 had met the learning outcomes, while 13 had not, thus failing to meet the predetermined success indicators. This indicates that the students' understanding of the material taught, specifically various diagrams, remained low. In learning theory, this aligns with the constructivist concept, which posits that students construct their understanding through learning experiences (Saleem *et al*., 2021; Shah, 2019). In mathematics learning, diagrams and pictures are important tools to help students understand complex concepts. However, if students lack a strong foundational understanding, they will struggle to use these tools effectively. The turus diagram and picture material in Cycle I have not yielded satisfactory results, with many students still struggling to apply and explain the information contained in the diagrams. Therefore, the low learning outcomes in this cycle indirectly indicate that the learning approach applied may not be practical enough in building an understanding of the concepts of turus diagrams and images.

In response to the results of Cycle I, the study continued to Cycle II, which was conducted on June 4, 2024. In this cycle, the material provided remained the same, namely, various diagrams discussing torus diagrams and images. However, in Cycle II, much better results were obtained, with an average learning success rate of 87.40%, indicating excellent progress. Of the 30 students, 25 completed the course, and only five did not. This improvement demonstrates that the learning strategy employed in Cycle II was successful in enhancing students' understanding of the material taught. According to Kolb's learning theory, direct experience in the learning process can improve understanding and information retention (Idkhan & Idris, 2021). In mathematics learning in Cycle II, the material on turus diagrams and images was integrated with the use of the STAD learning model, which encouraged collaboration and interaction among students. In the STAD model, students work in groups to understand and complete tasks related to diagrams, allowing them to exchange ideas and strategies (McLure *et al*., 2022). Active involvement in group discussions strengthens students' understanding of the concepts taught (Munna & Kalam, 2021). Thus, the approach used in Cycle II proved to be effective in improving student learning outcomes.

Five students in Cycle II did not complete the tasks, and further analysis revealed that they had difficulties with reading diagrams and calculating. This indicates that, although most students were able to follow the lessons well, certain groups required additional attention. When linked to Howard Gardner's concept of multiple intelligences, this can explain the variation in students' learning abilities, showing that each individual has different learning styles and tendencies (El-Sabagh, 2021). Therefore, a more differentiated approach in STAD model teaching needs to be considered by providing additional materials and strategies appropriate for students who experience difficulties.

Although the application of the STAD model has been successful in improving student learning outcomes, it is also necessary to emphasize the importance of continuous evaluation in the learning process and adjustment of the methods used. The application of a learning model that is responsive to student needs not only improves learning outcomes but also encourages their involvement and motivation in the learning process (Cahyana & Agustin, 2024). Thus, this study contributes to the development of more effective learning practices in the context of mathematics education, particularly at the elementary school level, and highlights the importance of a deep understanding of learning theories in designing targeted educational interventions.

CONCLUSION

This study shows that the application of the STAD learning model in two cycles successfully improved the mathematics learning outcomes of second-grade students. In Cycle I, the average learning success rate was only 63.39%, indicating that many students had not yet mastered the material. However, after improvements and developments were made in Cycle II, the average score increased significantly to 87.40%, with 25 out of 30 students achieving mastery. Nevertheless, there were still 5 students who had not yet mastered the material, indicating a need for further analysis of their difficulties in reading diagrams and calculating. This study emphasizes the importance of a differentiated approach in teaching in order to meet the individual learning needs of students. With continuous evaluation and adjustment of learning methods, it is hoped that student learning outcomes will continue to improve, contributing positively to educational practices at the elementary school level.

AUTHOR'S NOTE

The author declares that there are no conflicts of interest related to the publication of this article. The author confirms that the data and content of the article are free from plagiarism.

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