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Analysis of the Impact of Cooperative Learning Model Utilization on Mathematics Learning in Secondary Schools

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Abstract: The aim of this study is to analyze the impact of implementing the Cooperative Learning Model on mathematics education in secondary schools. Utilizing a Systematic Literature Review approach, a selection of literature from Google Scholar, IOSR Journal, and related journals published between 2017 and 2023 was investigated. The results of the research indicate that the application of the Cooperative Learning Model has a significant positive impact on both academic achievement and student motivation in mathematics education. However, there are still research gaps that need to be addressed, including a deeper understanding of the effectiveness of this model and the factors influencing its implementation. Further research is necessary to fill these gaps, thereby strengthening the understanding of the benefits and challenges associated with applying the Cooperative Learning Model in the context of mathematics education in secondary schools.

Keywords: Cooperative Learning Model, Mathematics Education

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A. INTRODUCTION

The importance of effective mathematics education at the secondary school level is paramount for students' academic progress (Asdlori, 2023). Implementing effective teaching methods can stimulate students' interest in learning, enhance their understanding of the material, and assist them in developing the logical and analytical thinking skills crucial for solving mathematical problems (Nurfadilah & Dori, 2019). Therefore, the development and implementation of effective teaching methods are crucial steps in ensuring the quality of mathematics education in junior high schools, thus fostering a competent generation ready to face future challenges more effectively.

Cooperative Learning Model is an instructional approach that emphasizes collaboration and interaction among students in achieving learning goals (Prasetyawati, 2021). The main concept of this model is cooperative learning, where students work together in small groups to attain a better understanding of the subject matter Sappaile et al. (2023) The key principles underlying the Cooperative Learning Model include positive interdependence among group members, individual responsibility for group success, active social interaction among students, utilization of social skills, and provision of positive feedback among group members

(Amriani, 2022). As a teaching method based on social interaction, the Cooperative Learning Model offers the potential to enhance students' mathematics learning outcomes through collaboration, discussion, and problem-solving together.

The effectiveness of the Cooperative Learning model, especially in the context of mathematics education at the secondary school level, has been a significant focus of research (Virgana et al., 2019). One of the main emphasized aspects is the improvement of students' academic achievement, reflected in their enhanced ability to grasp complex mathematical concepts (Hidayati et al., 2023). Additionally, this learning model strengthens students' group work and communication skills, which are crucial aspects in developing their social and interpersonal abilities (Nababan et al., 2023). Thus, these studies provide compelling evidence of the effectiveness of the Cooperative Learning model in enhancing mathematics learning outcomes at the secondary school level.

The utilization of cooperative learning models in the context of mathematics education at the secondary school level has demonstrated positive impacts on students' academic achievement, attitudes toward mathematics, and critical thinking abilities (Nirfayanti et al., 2023). Research indicates that cooperative learning methods enhance students' abilities to generalize mathematical concepts (Soomro & Arain, 2023). Another study by (J. Manurung, 2023) showcases the implementation of the Roundtable Table cooperative learning model to enhance mathematics learning interest in Class VIII-2 at SMP Negeri 2 Padangsidimpuan. Although it doesn't specifically mention the use of cooperative learning models in the context of mathematics education at the secondary level. Furthermore, teaching using cooperative approaches is recommended as it fosters a conducive learning environment, ultimately contributing to academic achievement improvement (Sarikaya, 2023). Moreover, the use of cooperative learning models is considered an effective means to promote inclusion and educational equality, aligning with efforts to achieve Sustainable Development Goals (Saborit et al., 2022). Lastly, the implementation of the Cooperative Model utilizing Ethnomathematics Approach has proven effective in mathematics education for junior high school students (Rusli et al., 2022). In conclusion, Cooperative Learning Models emerge as a valid, practical, and successful approach in enhancing mathematics learning outcomes in secondary schools.

The Cooperative Learning Model demonstrates significant potential in the development of mathematical learning theories and provides practical implications in the teaching field. Its implementation can enhance students' ability to generalize mathematical concepts (Nifayanti et al., 2023). Furthermore, this model also has a considerable effect on mathematics learning outcomes at the vocational high school level (Ridwan et al., 2022). The implementation of cooperative learning has been shown to have a positive impact on mathematics learning achievement, students' interest, and their educational backgrounds (A. S. Manurung et al., 2022). Additionally, the Student Teams Achievement Division (STAD) cooperative learning model also contributes to improving students' understanding of mathematical concepts (Susanto et al., 2021). These research findings underscore the importance of the Cooperative Learning Model in enhancing the quality of mathematics education and providing guidance for educational practitioners.

Several studies have demonstrated the effectiveness of cooperative learning in improving students' learning outcomes across various subjects. A constructivist teaching model that incorporates cooperative techniques significantly enhances thematic learning outcomes among students (Paramita et al., 2020). Similarly, cooperative learning reduces alcohol and tobacco use among high school students, mediated by a decrease in usage among peers (Van Ryzin & Roseth, 2018). However, it has been found that while goal setting enhances student motivation, it does not significantly impact learning outcomes (Fauziyah et al., 2023). Additionally, Strandell-Laine et al. (2018) noted that mobile collaboration interventions do not significantly improve individual outcomes but enhance certain contextual aspects of the learning environment. These findings collectively suggest that cooperative learning, when combined with other effective strategies, can serve as a potent tool for improving student learning outcomes in mathematics and other subjects.

Based on the synthesis of presented research findings, several gaps can be identified in the context of using the Cooperative Learning Model (CLM) in mathematics education at the secondary school level. By identifying these gaps, research on the Analysis of the Impact of Using the Cooperative Learning Model on Mathematics Education in Secondary Schools is expected to make a significant contribution by addressing these questions. Through a systematic literature review approach, this research aims to fill existing knowledge gaps and provide clearer guidelines for educational practitioners in optimizing the implementation of CLM in mathematics education at the secondary school level.

B. METHOD

The aim of this study is to analyze the impact of using the Cooperative Learning Model in mathematics education at the secondary school level. The primary focus is to understand the effects of implementing cooperative learning models on students' academic achievement, attitudes toward mathematics, and critical thinking abilities. Additionally, this research aims to identify the factors influencing the effectiveness of the Cooperative Learning Model in the context of mathematics education in secondary schools. Literature search was conducted through various academic databases, including Google Scholar, IOSR Journal, and relevant scholarly journals published between 2017 and 2023. Keywords used encompassed "Cooperative Learning," "Mathematics Education," "Secondary School," and other related keyword variations. Relevant articles were selected based on their relevance to the use of the Cooperative Learning Model in mathematics education at the secondary school level.

Inclusion and exclusion criteria have been established to ensure the accuracy and relevance of the selected literature. Inclusion criteria encompass studies that utilize the Cooperative Learning Model in the context of mathematics education at the secondary school level, while exclusion criteria include research that is irrelevant to the research topic or fails to meet the established quality standards. The literature selection procedure will be conducted meticulously to ensure that only literature meeting the inclusion criteria is considered for further analysis. Studies solely involving other educational levels or not specifically addressing the impact of Cooperative Learning Model usage on mathematics education at the secondary school level will be excluded. Experimental, quantitative, and qualitative research will be included in the analysis. The language of publication is not restricted. Once relevant

research is identified, pertinent data will be extracted. This includes information on research design, samples, outcomes, findings, and conclusions related to the effectiveness of using the Cooperative Learning Model in mathematics education at the secondary school level. The data will be systematically analyzed to identify patterns, trends, and potential research gaps.

C. RESULTS AND DISCUSSION

1. The Direct Effects of Implementing the Cooperative Learning Model on Students' Academic Achievement in Mathematics

The implementation of the Cooperative Learning Model has been shown to have a positive impact on students' academic achievement in mathematics at the secondary school level (Sarikaya, 2023; Soomro & Arain, 2023). Research conducted in various countries, including Turkey, Ghana, and the United States, asserts that the cooperative learning approach consistently enhances students' learning outcomes in mathematics. The research methods employed in these studies include pre-tests and post-tests, questionnaires, and interviews to collect data and evaluate the influence of cooperative learning on student performance.

Consistently, the research found indicates that students guided through cooperative learning approaches achieve higher learning outcomes in mathematics compared to those taught using conventional methods. Cooperative learning approaches not only enhance academic achievement but also improve students' attitudes toward mathematics, enhance critical thinking skills, and strengthen students' interest in the subject. Therefore, the use of the Cooperative Learning Model in the context of mathematics education at the secondary school level is highly recommended. Research conducted by Putra & Ramayani (2022) and Muhtar (2021) demonstrates the effectiveness of specific cooperative learning models, such as Numbered Heads Together and STAD, in enhancing students' understanding and performance across various subjects. Collectively, these studies imply that implementing cooperative learning can lead to improved academic achievement in mathematics at the secondary school level.

The research findings indicate that the Cooperative Learning model is effective in enhancing students' academic achievement in mathematics at the secondary school level. This teaching method can strengthen understanding of the material, increase student participation, and create an inclusive learning environment. Moreover, cooperative learning also promotes collaboration among students and develops their social skills. The conducted studies show consistency in finding that cooperative learning yields a positive impact on students' academic achievement in mathematics. However, it is important to note that its effectiveness may be influenced by contextual factors such as teacher support, classroom structure, and student needs.

2. The Influence of Student Learning Motivation in the Context of Mathematics Education

Several studies have indicated that the use of cooperative learning models can enhance students' motivation to learn mathematics (Damayanti et al., 2023; Rusli et al., 2022; Thomas & Martina, 2022). This approach involves active student participation, cooperation, and the application of various relevant teaching approaches, thereby potentially increasing students' interest and enthusiasm for learning mathematics (Atteh & Adusei, 2022). The effectiveness of the cooperative learning model in enhancing students' motivation and participation in mathematics learning has been demonstrated through various studies, including action research and quasi-experimental designs. The findings of these studies indicate that the cooperative learning approach can lead to improved academic performance and achievement in mathematics. Therefore, the implementation of the cooperative learning model in teaching mathematics at the secondary school level can be considered an effective strategy for enhancing students' learning motivation and overall performance in the subject.

The use of cooperative learning models has been proven to have a positive impact on student motivation in the context of mathematics education at the secondary school level (Fitri, 2017; Mujurimi, 2018; Sumarwoto, 2022). These models, such as Jigsaw, Student Team Achievement Division (STAD), Numbered Heads Together (NHT), Make-a-match, Talking Stick, and Snowball Throwing, have demonstrated to enhance students' motivation, participation, and creativity in learning (Mujurimi, 2018). Furthermore, the implementation of cooperative learning models has been shown to improve learning outcomes, particularly when combined with high student motivation (Sumarwoto, 2022).

Findings from various studies indicate that the implementation of the Cooperative Learning Model consistently enhances students' motivation in the context of mathematics education. Through active participation in collaborative learning, students feel more engaged in the learning process, which, in turn, boosts their interest and enthusiasm for mathematics. The use of various techniques within the cooperative model, such as group discussions, idea exchange, and shared responsibilities, enables students to feel a sense of ownership over their learning, which can be a crucial factor in enhancing motivation. Although there is ample evidence supporting the effectiveness of the Cooperative Learning Model in improving students' motivation in mathematics, it is important to note that these findings may be influenced by various contextual factors. For instance, the quality of implementing the cooperative model, teacher support, and student characteristics can affect how effectively the model enhances learning motivation.

3. Significant Differences in Students' Academic Achievement Using the Cooperative Learning Model

Significant differences in academic achievement exist between students who undergo mathematics education using the Cooperative Learning Model and those who do not. In one study involving 40 seventh-grade students, the experimental group implementing cooperative learning methods demonstrated a significant improvement in academic achievement compared to the control group using traditional teaching methods (Sarikaya, 2023). Another study involving 50 fifth-grade students also affirmed that cooperative learning has a positive impact on students' academic performance in mathematics (Soomro & Arain, 2023). Similarly, research involving 158 second-year students indicated that the cooperative learning approach

enhances students' academic performance in solving word problems involving fractions (Atteh & Adusei, 2022). Additionally, a study with eighth-grade students found significant differences in academic achievement in triangle subjects between the experimental group implementing cooperative learning and the control group using traditional teaching methods (Artawan, 2023).

Several studies have found significant differences in academic achievement between students participating in Cooperative Learning and those who do not. Research has identified significant differences in learning outcomes in the fields of economics and mathematics, respectively, with Cooperative Learning (Pratiwi et al., 2021). Another study also found that Cooperative Learning yields better learning outcomes in civics, especially when combined with high student motivation (Sumarwoto, 2022). Research by Fitri (2017) also emphasizes the potential of Cooperative Learning in primary education, offering various models for its implementation. Collectively, these studies indicate that Cooperative Learning can lead to better academic achievement in various subjects.

The research findings indicate that the implementation of the Cooperative Learning Model consistently results in significant improvements in students' academic achievement in mathematics. This suggests that the cooperative approach is effective in enhancing students' understanding of mathematical concepts and their ability to apply these concepts in problem-solving. The research methods employed in these studies can be considered sufficiently valid and reliable as they involve representative samples and utilize standard data collection procedures. However, it should be noted that there are other factors that can also influence students' academic achievement, such as environmental factors and individual motivation.

4. The Impact of Social Interaction Among Students in the Context of Mathematics Learning

The use of this instructional model has resulted in significant impacts on social interaction among students in the context of mathematics education at the secondary school level (Farohi, 2023; Kustantini et al., 2022; Nirfayanti et al., 2023). These models facilitate cooperation and active participation among students, creating an atmosphere where they can work together in small groups to grasp mathematical concepts (Ridwan et al., 2022). The stages in cooperative learning models, such as the active stage, collaborative stage, and inductive stage, encourage student engagement with each other and learning from their peers (Dwiasih, 2023). By employing cooperative learning models, student activities and learning outcomes in mathematics have been shown to improve, leading to enhanced mathematical generalization skills. Overall, cooperative learning models stimulate social interaction and create a supportive learning environment, strengthening understanding and application of mathematical concepts at the secondary school level.

The Cooperative Learning Model influences social interactions among students in the context of mathematics education at the secondary school level. Researchers have highlighted the effectiveness of cooperative learning in improving learning outcomes and the application of mathematical concepts in real-life situations (Agustinayanti, 2022). Further supporting this, Shamdani (2020) also emphasizes the positive impact of cooperative learning on students' motivation and learning activities. These studies collectively indicate that the cooperative

learning model can effectively enhance social interactions among students in the context of mathematics education.

The implementation of this model presents significant opportunities to enhance social interaction among students. These models not only provide students with the opportunity to collaborate in solving mathematical problems but also encourage communication, cooperation, and appreciation for each group member's contribution. This leads to more meaningful and significant learning for students, as they can learn from each other through discussions, idea exchange, and collaboration in achieving a deeper understanding of mathematical concepts. Studies conducted consistently highlight the effectiveness of cooperative learning models in enhancing social interaction among students in the context of mathematics education. These findings affirm that the cooperative approach is not only effective in improving understanding of mathematical concepts but also in strengthening social relationships among students. However, it is important to note that the effectiveness of cooperative learning can be influenced by various factors, including teacher skills, classroom structure, and individual student needs.

5. The Impact of Using Cooperative Learning Model on Developing Students' Critical Thinking Skills in Understanding Mathematical Concepts

In understanding mathematical concepts, the use of the Cooperative Learning Model has a significant impact on the development of students' critical thinking skills. Various studies have indicated that implementing cooperative learning models, such as Numered Head Together (NHT), leads to significant improvements in students' critical thinking abilities, including constructing simple explanations, sharpening basic skills, and the ability to draw conclusions (Siagian et al., 2023). Meta-analysis research has also concluded that the use of cooperative learning models significantly enhances students' critical thinking skills in mathematics (Sarikaya, 2023). Furthermore, employing cooperative learning methods in mathematics education has been shown to contribute to students' academic achievement in mathematics and the development of their disposition toward critical thinking (Habibah et al., 2023). Overall, the implementation of cooperative learning models has proven effective in advancing the development of students' critical thinking skills in understanding mathematical concepts in secondary schools.

The utilization of Cooperative Learning models, particularly the Make-A-Match and Jigsaw types, has been shown to positively impact students' critical thinking skills in understanding mathematical concepts at the secondary school level (Oktaviana, 2022; Shamdani, 2020). These models have proven to enhance learning motivation, deepen integrated science concept comprehension, improve academic performance, and significantly influence mathematics learning outcomes. These findings indicate that the Cooperative Learning Model is an effective approach for developing students' critical thinking skills in understanding mathematical concepts.

These findings indicate that the Cooperative Learning Model, particularly the NHT approach, provides strong support in developing students' critical thinking skills in understanding mathematical concepts. By emphasizing cooperation among students, this model enables them to think critically and actively engage in the learning process, thereby

enhancing their understanding of mathematical content. Existing research consistently provides evidence of the effectiveness of the Cooperative Learning Model in improving students' critical thinking skills in mathematics. However, it should be noted that these results may be influenced by certain contextual factors, such as curriculum, learning environment, and the quality of model implementation.

6. Effective Use of Cooperative Learning Model in Facilitating Understanding of Complex Mathematical Concepts

The Cooperative Learning Model has been proven successful in enhancing students' ability to generalize mathematical concepts in junior high school (Nirfayanti et al., 2023). Findings also indicate that this model has a positive effect on students' academic achievement in 5th-grade classrooms (Soomro & Arain, 2023). Moreover, the consistent use of the Cooperative Learning Model has been shown to improve students' critical and creative thinking abilities in mathematics (Siagian et al., 2023). Furthermore, the CIRC learning model utilizing mind mapping methods has been developed to enhance students' understanding of mathematical concepts, resulting in a significant improvement in student comprehension (Fauziah et al., 2022). Based on these findings, it can be concluded that the effective use of the Cooperative Learning Model can assist students in comprehending complex mathematical concepts in junior high school.

The use of Cooperative Learning models, such as Jigsaw, STAD, TGT, and Make-A-Match, has proven effective in facilitating understanding of complex mathematical concepts in secondary schools (Agustinayanti, 2022; Fitri, 2017; Shamdani, 2020). These models promote collaborative learning and knowledge transfer among students, resulting in improved learning outcomes and student motivation (Shamdani, 2020). Further integration of these models with ethnomathematics and realistic logical reasoning enhances students' understanding and application of mathematical concepts (Agustinayanti, 2022). The research findings indicate that the use of the Cooperative Learning Model is effective in enhancing students' understanding of complex mathematical concepts. However, it should be noted that the success of implementing this model can be influenced by factors such as teacher classroom management skills, student participation, and school curriculum support.

7. Factors Influencing the Success or Failure of Implementing the Cooperative Learning Model in Mathematics Education

The success or failure of implementing the Cooperative Learning Model in mathematics education at the secondary school level is influenced by several factors. One of these is the level of teacher activity and their ability to implement the teaching model (Munfarida, 2023; Rusli et al., 2022). Sometimes, teachers do not fully implement the model effectively, resulting in suboptimal outcomes (Sinaga et al., 2022). Another influential factor is the motivation and participation of students in the learning process (Thomas & Martina, 2022). The use of various relevant teaching models, such as cooperative learning, can enhance students' motivation and participation, thereby improving learning outcomes. Moreover, the effectiveness of cooperative learning in solving specific mathematical problems, such as word problems involving fractions, has been successfully demonstrated. This approach also has a positive

impact on students' academic performance. Therefore, effective implementation, student motivation, and the relevance of the mathematical content taught are crucial factors influencing the success of the Cooperative Learning Model in mathematics education at the secondary school level.

Several studies have examined the factors influencing the success of Cooperative Learning in mathematics education. Research has found that the use of Cooperative Learning models, such as Jigsaw and STAD, leads to improved learning outcomes and increased student interest in mathematics (Fitri, 2017; Utami, 2020). Further supporting these findings, Suherti & Tsuroya (2019) demonstrated a significant improvement in creative thinking skills among students using the STAD technique. However, other studies found no significant difference in communication skills between students using Cooperative Learning and those who did not (Patimah et al., 2018). Collectively, these findings suggest that the success of Cooperative Learning in mathematics education may be influenced by the specific model used, the level of student involvement, and the nature of the assessed learning outcomes.

The success rate of implementing the Cooperative Learning Model in mathematics education is influenced by several factors. The activities and abilities of teachers in applying the model play a crucial role in achieving optimal learning outcomes. A lack of understanding or inconsistent use of the model by teachers can diminish the effectiveness of cooperative learning. Student motivation and participation also serve as key factors in the success of this model, as active student involvement in learning contributes to achieving learning objectives. Additionally, the choice of cooperative learning model can impact learning outcomes, with certain models such as Jigsaw and STAD proven effective in improving student learning outcomes and interest in mathematics. Research findings indicate that the implementation of the Cooperative Learning Model has the potential to enhance mathematics education in secondary schools. However, challenges such as inconsistent implementation by teachers and a lack of significant variation in students' communication skills suggest that there is still room for improvement. Careful evaluation of the factors influencing the success of this model can aid in designing more effective learning strategies.

D. CONCLUSIONS AND SUGGESTIONS

Based on the evaluation of research outcomes, it can be concluded that the Cooperative Learning Model has a significant positive impact on improving academic achievement and student motivation in the context of mathematics education in secondary schools. However, there are still several research gaps that need to be addressed to deepen the understanding of the effectiveness and influencing factors of implementing this model. One of the gaps of concern is the lack of specific research examining the influence of the Cooperative Learning Model on students' critical thinking abilities in solving complex mathematical problems. Therefore, an urgent research topic that needs to be investigated in the future is "The Impact of the Cooperative Learning Model on the Development of Critical Thinking Skills in Solving Mathematical Problems in Secondary Schools." This research will help complement the understanding of the benefits of the cooperative model in enhancing students' cognitive skills and make a meaningful contribution to the development of mathematics education at the secondary school level.

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