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Optimizing Collaborative Learning as A Solution to Overcome Math Anxiety in Mathematics Learning: A Systematic Literature Review

Syahratu Cahya Ningtyas[1], Yurizka Melia Sari[2]
[1,2] Universitas Negeri Surabaya
* e-mail: syahratu.23041@mhs.unesa.ac.id yurizkasari@unesa.ac.id

Abstract
Mathematics anxiety is a major obstacle in the learning process that negatively impacts students' motivation and academic achievement. This study explores collaborative learning as a solution to reduce math anxiety using a Systematic Literature Review (SLR) method. Data were collected from SINTA and Google Scholar, resulting in six relevant articles published between 2019 and 2025. The findings show that collaborative learning models such as Problem-Based Learning, Teams Games Tournament (TGT), Student Teams Achievement Division (STAD), Group Investigation, Fan-N-Pick, and Heroe's can effectively lower students' math anxiety. These models share key features—active learning, enjoyable environments, and positive social interaction—that foster both emotional and intellectual engagement. As a result, students experience increased confidence and better understanding of mathematical concepts. Collaborative learning, when adapted to students' characteristics, is a promising pedagogical approach to enhance mathematics education quality and minimize anxiety across various educational levels.

Keywords: *collaborative learning, math anxiety; math education; Systematic Literature Review (SLR)*

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INTRODUCTION

Learning mathematics is often a challenge for many students. Although mathematical concepts are widely applied in everyday life, in reality, many students avoid mathematics lessons and consider mathematics to be a difficult and boring subject. This aligns with research findings indicating that 45% of students perceive mathematics as a fairly difficult subject (Siregar & Restati, 2017). Many students view mathematics as a frightening and unpleasant subject due to its abstract, logical, and systematic nature, as well as its abundance of confusing symbols and formulas (Belbase, 2010). Such negative attitudes toward mathematics typically emerge when students encounter difficulties in solving problems or when facing exams. If students repeatedly experience these conditions, their negative attitudes may evolve into mathematics anxiety (Auliya, 2016).

Mathematics anxiety is a mental state characterized by unavoidable worry and negative feelings (Solikah, 2012). Specifically, math anxiety refers to unhealthy emotional reactions that occur when someone faces mathematical problems, causing them to panic, lose their composure, feel depressed, resigned, restless, and afraid, accompanied by psychological reactions such as sweating, clenching fists, feeling sick, vomiting, dry lips, and paleness (Auliya, 2016). This

condition cannot be ignored, as it will hinder the learning process of students and impede educational goals.

In Indonesia, approximately 68% of students experience moderate to high levels of math anxiety, as stated in a study conducted. Students with high levels of math anxiety tend to have low math achievement (Vahedi & Farrokhi, 2011). Excessive anxiety can hinder information processing and logical thinking abilities, which in turn affects students' low learning outcomes in mathematics. This condition is reflected in the results of the 2018 Program for International Student Assessment (PISA) survey, particularly in the mathematics category, where Indonesia ranked 73rd out of 80 countries participating in the program with an average score of 379. Indonesia's average score is still far behind China, which ranked first with an average score of 591 (Permana et al., 2020).

Anxiety towards math can be influenced by several factors including personality factors, environmental factors, and intellectual factors (Peker, 2009). Personality factors come from within the student, such as student confusion when receiving and understanding the material but being reluctant to ask questions, as well as low confidence in mathematical abilities that can affect student expectations. Environmental factors are factors that come from outside the student or come from the student's environment, such as having unpleasant experiences during classroom learning, being scolded by the teacher in front of classmates, high demands from parents who expect their children to excel in mathematics, and the application of inappropriate teaching models and methods, making students feel that mathematics is only about memorizing formulas. Meanwhile, intellectual factors are factors originating from the students' cognitive abilities, such as not finding a learning style that suits them, a lack of confidence in their abilities, and not feeling the benefits of studying mathematics.

Various efforts have been made to overcome the problem of math anxiety, which often hinders the learning process of students. Some common approaches that have been implemented include counseling, emotional management training, and the use of engaging learning media. These efforts have indeed shown fairly positive results in reducing math anxiety levels, but they have not yet fully addressed the root cause of math anxiety. Therefore, another effective approach to addressing math anxiety is the implementation of a collaborative learning model. The use of a collaborative learning model during learning has been shown to have a positive impact on student learning outcomes (Marhamah et al., 2017). The collaborative learning model is based on interaction theory, which views social interaction as a means of constructing meaning in the learning process (Setyaningsih, 2014). In the learning process, collaborative learning is a strategic step because the collaborative model enables students to make progress in the learning process (Sato, 2014).

Based on the introduction above, it is hoped that this study can provide new insights into the factors and impacts of math anxiety experienced by students, as well as provide concrete strategies for educators in implementing effective collaborative learning and improving the quality of mathematics learning. With the optimization of collaborative learning, it is hoped that students will not only understand mathematical concepts better but also be able to reach their full potential and apply mathematical concepts.

METHOD

This study uses the Systematic Literature Review (SLR) method. The SLR method is a research method that summarizes the results of primary research to present more comprehensive and balanced facts (Rahmawati & Juandi, 2022). This method was chosen to analyze the optimization of collaborative learning in overcoming math anxiety because the researchers wanted to obtain a comprehensive and systematic overview of the topic to be discussed from various perspectives. Additionally, using SLR allows researchers to identify gaps in the literature and develop a deeper understanding of the research topic. The steps required when using the SLR method include formulating research questions (developing research questions), searching for articles or literature relevant to the research theme (developing the search strategy), applying

inclusion criteria to select articles (selection criteria), evaluating and analyzing data, and reporting research findings (interpreting) (Andani, M., et al, 2021).

Search Process

The initial stage involved searching for data sources collected from articles in the Sinta database and using Google Scholar. The search was conducted through Sinta and Google Scholar using the keywords "Mathematics Anxiety" and "Collaborative Learning." The next stage involved selecting data based on the title, abstract, and relevance to the research question, which was how the cooperative learning model could be applied to overcome mathematics anxiety. The next step is a full-text review, which involves grouping the data into those that meet the inclusion or exclusion criteria that have been determined. The process of data collection and selection can be seen in Figure 1 below:

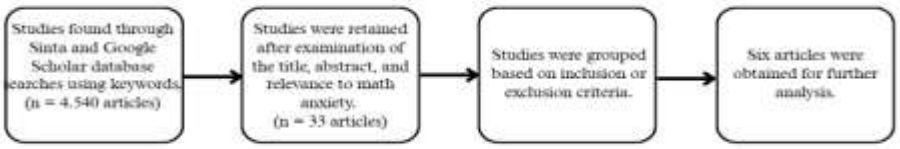

Figure 1 Data Selection Stages

Based on the image above, six articles were obtained. The selected data truly met the criteria for the research theme. The next step is to write up the research findings.

Inclusion and exclusion criteria

Table 1 Inclusion and Exclusion Criteria

	Inclusion	Exclusion
Literature Type	Articles published in scientific journals (peer-reviewed journals)	Papers, theses, dissertations, and sources not published in scientific journals
Contents	Discussing math anxiety and collaborative learning	Does not discuss math anxiety and collaborative learning.
Language	Indonesian and English	Other than Indonesian and English
Timeline	2019 - 2025	Before 2019
Field of Study	Topics related to math anxiety and collaborative learning	Outside the context of math anxiety and collaborative learning

DISCOVERY AND DISCUSSION

After obtaining data sources in the form of articles collected through searches on the Sinta and Google Scholar databases using the keywords "Mathematics Anxiety" and "Collaborative Learning," the articles were then included based on their criteria and relevance to the focus of this study, which is related to the implementation of collaborative learning models as an optimization strategy to address math anxiety. As a result of this inclusion process, a total of 6 articles were selected for further analysis.

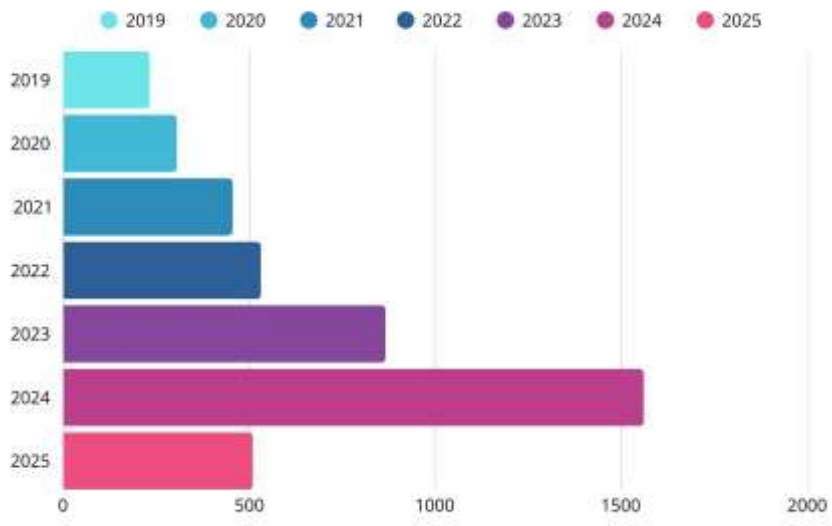

Figure 2 Number of Articles by Year

Over the past seven years, almost every year there have been publications discussing the relationship between learning models and math anxiety, and the number of such publications has continued to increase. This shows that from the past until now, issues related to the application of learning models and anxiety in mathematics remain unresolved, and continue to be a major concern and important issue in the world of education.

Table 2 Various Cooperative Learning Models

Learning Model	Source
Problem-Based Learning	(Dewi & Simamora, 2022); Jayantika et al., 2020; Koesmaryono & Nuhyal Ulia, 2020; Purwandari et al., 2020)
Teams Games Tournament	(Asih & Prihatnani, 2021); Wati et al., 2022)
Student Teams Achievement Division	(Asih & Prihatnani, 2021)
Group Investigation	(Azizah, 2021)
Fan-N-Pick	(Nugrahwati & Sintawati, 2021)
Here's	(Kurniawan & Budiyono, 2021)

As shown in Table 2, of the six studies reviewed, there were six different learning models applied to overcome math anxiety. Among these models, the Problem-Based Learning model was the most widely used approach.

These various learning models are applied at different levels, ranging from elementary school (SD), junior high school (SMP), and senior high school (SMA), to higher education (PT).

The following is a summary of the articles:

Table 3 Summary of Research Reviewed

No.	Researcher, Title	Learning Model	Results
1.	Sri Dewi, Risma Simamora. Analysis of Student Anxiety in Problem-Based Learning Mathematics Instruction at SMP Negeri 3 Kota Jambi	*Problem-Based Learning*	The study was conducted on 40 selected eighth-grade students at SMP Negeri 3 Kota Jambi. The results showed that Problem-Based Learning helped reduce students' math anxiety levels. Overall, students' anxiety levels were classified as mild, with an average score of 1.25. Fear was the dominant factor in students' anxiety. This model helps foster good interpersonal relationships, supports a better understanding of mathematics, and encourages learning that is not solely focused on memorization.
2.	Jati Lasworo Asih, Erlina Prihatnani. Comparison of Trigonometry Learning Outcomes and the Application of STAD and TGT in Relation to Anxiety Levels.	*Teams Games Tournament* (TGT) *Student Teams Achievement Division* (STAD)	The study was conducted on tenth-grade students at SMA Negeri 3 Salatiga. Although the two learning models (STAD and TGT) have different approaches, the results of the study show that there is no significant difference in mathematics learning outcomes between the two models, including when viewed from the interaction between the model and the level of student anxiety. This shows that cooperative learning models applied in a pleasant atmosphere can stabilize learning outcomes.
3.	Luthfi Nur Azizah *Guided Inquiry with the Group Investigation Model to Improve Achievement and Reduce Mathematics Anxiety*	*Group Investigation*	This classroom action research was conducted on eighth-grade students in class VIII D at SMPN 2 Sleman. The results of the study indicate that the implementation of the Group Investigation model using the Guided Inquiry method significantly reduced students' mathematics anxiety levels and improved academic performance. Students' anxiety levels decreased by 58% to the low category by the end of cycle II. Additionally, 87.10% of students exceeded the minimum competency standard (KKM) with an average score of 70.97. The learning environment became more active, creative, and enjoyable, thereby maximizing student engagement.
4.	Silvya Nugrahwati, Mukti Sintawati, Sutaryo. Fan-N-Pick: A Learning Model to Improve Learning Outcomes and Reduce Math Anxiety	*Fan-N-Pick*	This classroom action research was conducted on 12 fifth-grade students at SDN 163/X Catur Rahayu. The results showed that the application of the Fan-N-Pick model significantly reduced students' math anxiety from a score of 55.2 (cycle I) to 11.4 (cycle II) and increased student learning achievement from 83.3% to 100%. This learning method, which involves group interaction and games, created a fun and participatory atmosphere for the students.
5.	Heru Kurniawan & Budiyono	*Here's*	The study was conducted on 87 third-semester students in a Multivariate Calculus course. This

No.	Researcher, Title	Learning Model	Results
	Hero's Model: Case Study to Reduce Students' Learning Loss and Anxiety		model successfully reduced students' academic anxiety levels and prevented learning loss symptoms during online learning due to the COVID-19 pandemic. The average reduction in students' anxiety levels was recorded at 12%, and 87% of them passed the course. This model also fostered social interaction and emotional support, which strengthened students' understanding of concepts and their confidence in learning mathematics.

Based on the results of the study conducted on the selected articles presented in Table 1, it is known that there are several learning models that have been implemented and are able to reduce math anxiety.

The learning model offered by Dewi and Simamora is the Problem-Based Learning model. The Problem-Based Learning model is a learning approach that places students as active problem solvers. In using this learning model, students do not just memorize words. Instead, students are encouraged to solve real-world problems, thereby fostering the development of critical thinking and problem-solving skills through the investigation, guidance, and support of meaningful contextual issues. In the learning process using the Problem-Based Learning model, teachers act as facilitators guiding students to solve problems or find solutions by posing thought-provoking questions, providing strategic guidance, and supporting the exploration of mathematical concepts. The use of the Problem- Based Learning model has been proven to help reduce math anxiety because students are not merely passive recipients of information but are allowed to explore. This creates an interactive and challenging learning environment, builds students' confidence and independence, and fosters enjoyable learning experiences, thereby improving math learning outcomes while reducing math anxiety.

The next learning models offered by Asih and Prihatnani are Teams Games Tournament (TGT) and Student Teams Achievement Division (STAD). The TGT learning model is one of the cooperative learning approaches that combines working together in a group with elements of games or competitions. In TGT, students are divided into heterogeneous small groups, and then they learn together before participating in academic games designed to test their understanding of the material they have learned. TGT is considered one of the models that can reduce math anxiety because its implementation creates a fun and competitive atmosphere, fostering a positive learning environment. Such a learning atmosphere can help stabilize students' learning outcomes and reduce the anxiety they experience. Meanwhile, the Student Teams Achievement Division (STAD) is a cooperative learning model that emphasizes group collaboration to achieve academic goals. In this model, students are divided into small heterogeneous groups, and each group member is responsible not only for understanding the material for themselves but also for helping other group members to understand the material comprehensively. The STAD learning mechanism can certainly create a supportive and collaborative classroom atmosphere and stabilize student learning outcomes. Although the implementation of STAD and TGT differs, it was found that the results of their application did not show significant differences in students' mathematics learning outcomes, both overall and when examining the interaction between the learning model and students' anxiety levels.

The learning model used is a combination of Guided Inquiry and the Cooperative Learning Model of the Group Investigation (GI) type. The Group Investigation learning model is a cooperative approach that involves students in small, heterogeneous groups, where they actively participate in planning, investigating, and presenting learning outcomes based on a mutually agreed-upon topic. Meanwhile, Guided Inquiry is an inquiry-based learning approach where the

teacher provides problems and supporting resources, while students are given the freedom to design their steps to solve them. The combination of Guided Inquiry and Group Investigation aims to create an active, collaborative, and focused learning environment. Through this approach, students are not only required to understand mathematical concepts in depth but also learn to collaborate, discuss, and develop critical thinking skills in a supportive environment. The application of this combination is effective in improving mathematics learning outcomes while reducing students' anxiety levels. An open, collaborative, and intellectually challenging learning environment helps students feel more confident, motivated, and free from the excessive pressure that often triggers math anxiety.

The learning model used by Nugrahwati, Sintawati, and Sutaryo is the Fan-N-Pick cooperative model. The Fan-N-Pick model is a learning model that involves group cooperation by combining elements of card games, where the cards contain questions or commands related to the material being studied. Through the Fan-N-Pick model, students are actively involved in collaborative discussion and understanding of the material. Research indicates that the implementation of the Fan-N-Pick model is effective in improving mathematics learning outcomes and reducing students' anxiety levels. Interactions among group members, emotional support, and a pleasant learning environment make students more confident and comfortable in participating in the learning process.

The last learning model examined is the Hero's Model. Developed by Kurniawan and Budiyono, this learning model is an acronym for five stages of learning, namely: Hear (listening), Explore (exploring), Respond (responding), Organize (organizing), and Share (sharing). This model is based on case studies, where students are encouraged to understand and solve contextual problems through an active, reflective, and structured learning process. The Heroe's Model emphasizes critical, collaborative, and reflective thinking processes, which can help students develop a deep understanding of mathematical concepts. Research indicates that the Heroe's Model can minimize the impact of post-pandemic learning loss and reduce math anxiety levels. By focusing on real-world contexts, open dialogue, and student-centered learning, this model provides meaningful learning experiences.

CONCLUSION

Based on the studies that have been conducted, it can be concluded that the learning models found are cooperative and can be said to be effective in overcoming math anxiety, namely Problem-Based Learning (PBL), Teams Games Tournament (TGT), Student Teams Achievement Division (STAD), Group Investigation (GI), Fan-N-Pick, and Heroe's. Each of these learning models has different syntax, mechanisms, and ways of working to reduce students' math anxiety. However, there are similarities among all these learning models that enable them to work effectively in addressing math anxiety. Essentially, these learning models aim to make students active, feel engaged, and facilitate collaboration among students in the learning process, so that negative emotions such as fear, anxiety, tension, worry, and other emotions related to mathematics can be redirected, reduced, or even eliminated.

This study is expected to be a useful source of information for educators in overcoming math anxiety experienced by students. This research can be used as a basis for selecting and implementing appropriate learning models, tailored to the conditions and characteristics of students in the classroom. Optimizing the implementation of effective collaborative learning is not only expected to help students understand mathematical concepts better but also encourage them to reach their full potential and apply mathematical concepts in their daily lives. Thus, efforts to address math anxiety can be more targeted and have a positive impact on improving the overall quality of math learning. Further researchers are encouraged to explore other collaborative learning models or delve deeper into the role of educational technology in reducing math anxiety, so that the solutions offered become more relevant and adaptive to learning needs in the digital age.

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