



THE EFFECTIVENESS OF THE CREATIVE PROBLEM SOLVING MODEL IN ENHANCING STUDENTS' MATHEMATICAL COMMUNICATION SKILLS: A SYSTEMATIC LITERATURE REVIEW

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ABSTRACT

Mathematical communication skills are a crucial competency in 21st-century education, enabling students to express ideas, reason logically, and solve mathematical problems through various representations. This study aims to examine the impact of the Creative Problem Solving (CPS) model on students' mathematical communication skills using a Systematic Literature Review (SLR) approach. This review synthesizes studies published between 2020 and 2025 that examine the implementation of CPS in mathematics learning. Findings indicate that the CPS model positively impacts mathematical communication skills by encouraging concept exploration, discussion, idea expression, and the use of mathematical representations. The stages of the CPS fact-finding, problem-finding, idea-finding, solution-finding, and acceptance-finding support students' active engagement in the problem-solving process. Furthermore, the reviewed studies report improvements in learning outcomes, creativity, and metacognitive skills. However, the limited number of studies specifically investigating the direct relationship between CPS and mathematical communication limits the generalizability of the findings. Overall, CPS demonstrates strong potential for improving mathematical communication skills through interactive and exploratory learning experiences. Further research is suggested in a broader educational context.

Keywords: *mathematical communication, creative problem solving, mathematics learning.*

INTRODUCTION

Mathematical communication is a fundamental competency in 21st-century education, equipping students with the skills to reason logically, construct mathematical arguments, solve problems, and express ideas through spoken and written language, as well as various mathematical representations. According to the National Council of Teachers of Mathematics (NCTM, 2000), mathematical communication is a process standard that must be developed in mathematics learning. This capability encompasses students' ability to organize and consolidate mathematical thinking, communicate ideas clearly to others, analyze the mathematical thinking of peers, and use mathematical language and representations appropriately. Therefore, mathematical communication

serves not only as a means of conveying information but also as a tool for building conceptual understanding and developing students' mathematical reasoning. The concept of mathematical communication began to receive attention in mathematics education since its introduction by Moseley et al. (1993) and continues to develop as a competency on a par with reading, writing, and arithmetic. Since then, mathematical communication has been integrated into various educational contexts to help students understand concepts, analyze problems, and convey solutions appropriately through relevant mathematical representations (Chasanah et al., 2020).

In mathematics learning, the development of mathematical communication can be facilitated through the application of learning models that encourage active student involvement in the process of thinking, discussing, and solving problems. One learning model that is considered capable of supporting the development of these abilities is Creative Problem Solving (CPS). This model was first developed by Osborn (1953) and later refined by Parnes (1967) as a systematic approach that emphasizes the process of creative problem solving. CPS consists of several main stages: fact finding (fact identification), problem finding (problem formulation), idea finding (idea exploration), solution finding (solution selection), and acceptance finding (solution implementation). Through these stages, students are encouraged to explore various alternative solutions, evaluate the resulting ideas, and convey and defend the chosen solution logically.

Theoretically, CPS aligns with the constructivist view that positions students as active subjects in constructing knowledge through learning experiences and social interactions (Vigotsky 1978). The processes of discussion, argumentation, reflection, and presentation that occur during the implementation of CPS provide students with opportunities to organize mathematical thinking, explain problem-solving strategies, and use various mathematical representations appropriately. Therefore, CPS not only contributes to the development of creative thinking and problem-solving skills but also has the potential to improve students' mathematical communication skills, both verbally and in writing. Previous studies have shown that the implementation of CPS has a positive impact on various students' mathematical abilities. van Hooijdonk et al. (2020) found that *the fact-finding, problem-finding, and solution-finding processes* in CPS help students develop creative thinking skills and communicate solutions more systematically. Murwaningsih and Fauziah (2020) reported that CPS is effective in improving students' divergent thinking skills through activities exploring various alternative solutions. These divergent thinking skills contribute to students' ability to express ideas and arguments more openly.

Various studies have shown that the Creative Problem Solving (CPS) model positively contributes to the development of students' mathematical communication skills. Tambunan (2021) reported that students who learned using CPS had better mathematical communication skills compared to students who participated in conventional learning. This improvement was evident in students' ability to express mathematical ideas, explain problem-solving procedures, and convey solutions more systematically. Similar findings were reported by Rachman and Rosnawati (2021), who showed that the implementation of CPS had a positive effect on students' mathematical communication, mathematical reasoning, and self-esteem. Furthermore, Sukmawati and Kaigere (2024) found that CPS effectively improved students' ability to use mathematical representations and explain problem-solving processes across various learning styles. Overall, these findings indicate that CPS not only supports the development of problem-

solving and creative thinking skills but also provides space for students to communicate mathematical ideas, strategies, and solutions more effectively.

However, research findings on the effectiveness of CPS on mathematical communication are still scattered across different educational levels, student characteristics, and learning contexts. Most studies focus on testing the effectiveness of CPS on creative thinking, problem-solving, or mathematical reasoning skills, while studies specifically synthesizing empirical evidence on the effect of CPS on mathematical communication skills are still relatively limited. Furthermore, there is limited research identifying the most effective CPS implementation patterns in supporting the development of mathematical communication across various learning contexts. These limitations result in a lack of a comprehensive overview of research trends, implementation characteristics, and factors supporting the success of CPS in improving students' mathematical communication.

Therefore, a Systematic Literature Review (SLR) is needed to identify, evaluate, and synthesize research findings related to the effectiveness of the Creative Problem Solving model in improving students' mathematical communication skills. By synthesizing research published in the 2020–2025 period, this review is expected to provide a more comprehensive overview of research trends, methodological approaches used, and key findings related to the implementation of CPS in mathematics learning. Based on the description, this study aims to conduct a systematic literature review on the effectiveness of the Creative Problem Solving (CPS) model in improving students' mathematical communication skills. The results of this study are expected to provide theoretical contributions in enriching studies on mathematics learning based on creative problem solving as well as practical contributions for teachers, researchers, and policymakers in developing learning strategies that can support the continuous improvement of students' mathematical communication.

METHOD

This study employed a Systematic Literature Review (SLR) method by examining research articles published between 2020 and 2025 that were relevant to the use of the *creative problem-solving* (CPS) model to improve students' mathematical communication skills. The search process was conducted through leading academic databases such as Scopus, Taylor & Francis, Springer, and Google Scholar, using a combination of keywords including "*creative problem solving*," "*CPS*," "*mathematical communication*," and "*student communication skills*."

The inclusion criteria consisted of empirical research articles that (1) discussed the use of CPS in mathematics learning (2) emphasized research that measured mathematical communication skills or skills directly related to mathematical communication, such as mathematical reasoning, mathematical argumentation, and mathematical representation, both written and symbolic representation (3) were published in peer-reviewed journals, and (4) were available in full text in English or Indonesian.

Meanwhile, exclusion criteria include: (1) non-empirical articles (e.g., conceptual papers, literature reviews), (2) publications from 2020-2025, (3) studies without full-text access, and (4) research that only discusses *creative problem solving* (CPS) in general without an explicit link to the development of mathematical communication skills.

All selected studies were systematically analyzed based on their research design, educational context, learning context, *the creative problem-solving* (CPS) model used, and findings related to mathematical communication skills. This analysis provides a comprehensive mapping of current research trends, effective pedagogical strategies, and empirical evidence on how the application of *the creative problem-solving* (CPS) model contributes to improving students' mathematical communication skills across various educational contexts.

RESULTS AND DISCUSSION

The literature search yielded five empirical studies published between 2020 and 2025 that specifically addressed the application of *the creative problem-solving* (CPS) model to develop students' mathematical communication skills. These studies were analyzed based on their research objectives, methodological design, key findings, and implications for mathematics learning practices . A synthesis of the study results is presented in Table 1 to illustrate the similarities, differences, and contributions of each study and to provide a basis for discussing current trends and the effectiveness of the *creative problem-solving* (CPS) model in supporting mathematical communication

RESULTS

TABLE 1Synthesis results literature

Author (Years)	Title	Method	Research Findings	Implications
van Hooijdonk et al. (2020)	Analyzing the role of CPS stages in the creative problem solving process of elementary school students	Experimental Quantitative	The stages of fact finding, problem finding, and solution finding help students develop the ability to identify problems, generate ideas, and communicate solutions systematically.	
Murwaningsih & Fauziah (2020)	Knowing the effectiveness of CPS on students' divergent thinking abilities	Elementary school students' experiments	CPS is more effective than direct learning in improving divergent thinking skills which support the ability to express ideas and arguments.	



Tambunan (2021)	Analyzing the influence of CPS on students' mathematical reasoning and communication abilities	Quasi-experimental design	CPS significantly improves mathematical communication and mathematical reasoning skills compared to conventional learning.
Rachman & Rosnawati (2021)	Testing the effectiveness of CPS in terms of reasoning, communication, and self-esteem abilities	Quasi Experiment	CPS has a positive influence on mathematical communication skills and increases students' confidence in expressing mathematical ideas.
Simbolon (2022)	To determine the effectiveness of CPS on students' mathematical reasoning and communication abilities	Experiment	Students who learned using CPS had better mathematical communication and reasoning skills than the control group.
Sukmawati & Kaigere (2024)	Analyzing the influence of CPS on mathematical communication skills from the perspective of students' learning styles	Quasi Experiment	CPS improves students' mathematical communication skills across various learning style characteristics.

Septiani & Hidayati (2024)	Analyzing the influence of CPS based on an open-ended approach on high-level mathematical thinking skills	Experiment	Open-ended CPS encourages students to explain mathematical ideas, strategies, and solutions in more depth.
Pramesti & Mardaningtyas (2025)	Examining the effectiveness of CPS on mathematical creativity and communication at different levels of self-regulation	Mixed Method	CPS enhances mathematical creativity and communication in students with varying levels of self-regulated learning.

A synthesis of eight analyzed studies shows that the Creative Problem Solving (CPS) learning model has developed as a pedagogical approach that is not only oriented towards problem solving but also contributes significantly to the development of students' mathematical communication skills. The various studies reviewed show that CPS provides opportunities for students to actively engage in the thinking process, express ideas, construct arguments, and communicate mathematical solutions through various forms of representation. In the context of mathematics learning, mathematical communication skills develop when students are not only asked to find the correct answer but also to explain the reasons, procedures, and strategies used in solving problems.

Findings by van Hooijdonk et al. (2020) show that the main stages of CPS—fact-finding, problem-finding, and solution-finding—provide students with the opportunity to identify important information, formulate problems clearly, and generate alternative solutions. This process indirectly encourages students to systematically communicate their thinking to peers and teachers. The exploration of ideas, a key characteristic of CPS, makes communication an integral part of the problem-solving process. Thus, students learn not only to find solutions but also to explain and defend those solutions through logical argumentation.

The research results of Murwaningsih and Fauziah (2020) reinforce these findings by showing that CPS effectively improves students' divergent thinking skills. Divergent thinking skills enable students to generate various alternative solutions to a problem. In mathematics learning, the diversity of ideas that emerge during the problem-solving process encourages students to more actively express their ideas, justify their chosen strategies, and compare their solutions with those of other students. This activity directly supports the development of mathematical communication skills because students are trained to convey ideas clearly and understandably.

Tambunan's (2021) research shows that students learning using the CPS model have better mathematical communication skills than students who follow conventional learning. This improvement is evident in students' ability to systematically write problem-

solving steps, explain relationships between mathematical concepts, and use mathematical symbols and representations appropriately. Group discussion activities, which are part of the CPS implementation, allow students to exchange ideas, clarify understanding, and convey mathematical arguments in a more structured manner. These findings demonstrate that CPS can create a learning environment that encourages more meaningful mathematical interactions.

A similar perspective was found by Rachman and Rosnawati (2021), who stated that CPS has a positive influence on students' mathematical communication skills and self-esteem. Students who have the opportunity to express ideas and defend their opinions during the learning process tend to have higher communication confidence. This self-confidence contributes to students' courage in presenting mathematical arguments, answering questions, and explaining their solutions. Thus, CPS not only improves students' cognitive aspects but also supports the development of affective aspects, which play a crucial role in mathematical communication.

Simbolon's (2022) findings indicate that the effectiveness of CPS is not only seen in students' mathematical communication skills but also in their mathematical reasoning abilities. In the CPS process, students are required to evaluate various alternative solutions before determining the most appropriate strategy. This activity encourages students to use logical reasoning while communicating the reasons underlying their solution choices. This relationship between mathematical reasoning and communication demonstrates that CPS is capable of integrating various mathematical abilities simultaneously through structured problem-solving activities.

A study by Sukmawati and Kaigere (2024) showed that mathematical communication skills improved through CPS in students with various learning styles. The results showed that students became better able to explain problem-solving procedures, use mathematical symbols appropriately, and convey mathematical ideas both orally and in writing. These findings indicate that CPS has high flexibility, allowing it to be applied to various learning situations without losing its effectiveness in developing mathematical communication skills.

Meanwhile, research by Septiani and Hidayati (2024) shows that integrating CPS with an open-ended approach can improve students' ability to develop and explain various problem-solving strategies. This approach provides students with the opportunity to generate more than one solution, thus enriching and diversifying the mathematical communication process. Students not only explain the final answer but also outline the reasoning, procedures, and relationships between concepts used during the problem-solving process.

Furthermore, Pramesti and Mardaningtyas (2025) found that the effectiveness of CPS is optimal when supported by strong self-regulated learning skills. Students who are able to regulate their learning process tend to be more active in planning problem-solving strategies, monitoring their thinking processes, and evaluating the clarity of their arguments. This finding suggests that mathematical communication is influenced not only by the learning model used, but also by students' ability to manage their learning process independently.

Overall, the synthesis of eight studies demonstrates a consistent pattern regarding the effectiveness of the Creative Problem Solving model in improving students'

mathematical communication skills. CPS provides students with opportunities to develop ideas, discuss problem-solving strategies, present arguments, and use various mathematical representations to explain their solutions. Through creative and collaborative problem-solving activities, mathematical communication becomes an integral part of the learning process.

Based on the reviewed literature, several analytical patterns can be identified as follows:

1. Creative Problem Solving encourages students to actively express mathematical ideas and concepts through the process of identifying problems, exploring alternative solutions, and evaluating the results of the solution.
2. The CPS stages facilitate the development of mathematical argumentation skills, as students are encouraged to explain and defend their chosen solution strategies logically.
3. Discussion and collaboration activities in CPS improve mathematical communication skills, both in oral and written forms.
4. CPS reinforces the use of various mathematical representations, such as symbols, diagrams, tables, graphs, and mathematical models to explain concepts and the solutions obtained.
5. The success of CPS in improving mathematical communication skills is influenced by supporting factors, such as divergent thinking skills, mathematical reasoning, self-confidence (self-esteem), and self-regulation skills (self-regulated learning).

Thus, the Creative Problem Solving (CPS) model can be understood not only as a problem-solving-oriented learning approach but also as a pedagogical strategy capable of developing students' mathematical communication skills comprehensively through creative, argumentative, collaborative, and reflective thinking processes. These findings strengthen CPS's position as a relevant learning model to support the development of 21st-century mathematical competencies.

CPS Stages			Mathematical Communication Indicators	Function in learning
<i>Fact Collection</i>	<i>Finding</i>	(Data	Students are able to identify information, explain known facts, and interpret mathematical problems using appropriate language.	Help students understand problem situations and communicate mathematical information systematically before solving them.
<i>Problem Finding</i>	(Problem Formulation)		Students are able to formulate mathematical problems and change contextual problems into mathematical form.	Develop students' ability to express ideas and understand the relationship between context and mathematical concepts.
<i>Finding Ideas</i>	(Formulation of the problem)	of the	Students are able to formulate mathematical problems and change	Encourage creative thinking and the ability to convey mathematical ideas

<i>Solution Finding</i> (Solution Selection)	contextual problems into mathematical form. Students are able to provide reasons, explain solution steps, and defend mathematical arguments.	through discussion and exploration. Train logical and structured argumentative communication and mathematical reasoning skills
<i>Acceptance Finding</i> (Solution Implementation)	Students are able to present the results of the solution using symbols, tables, graphs, diagrams, or other mathematical representations.	Help students communicate mathematical solutions clearly, accurately, and easily understood.

DISCUSSION

Trends in the Use of Creative Problem Solving (CPS) Models on Mathematical Communication Skills

An analysis of eight studies published between 2020 and 2025 shows that the Creative Problem Solving (CPS) model is increasingly being used as a mathematics learning approach oriented toward developing students' creative thinking and mathematical communication skills. Research trends over the past five years demonstrate a paradigm shift from a mathematics learning approach focused on procedures to one that positions students as active problem solvers capable of expressing, explaining, and defending their mathematical ideas. In this context, CPS is no longer viewed merely as a problem-solving strategy, but as a pedagogical framework that encourages students to develop mathematical communication through idea exploration, discussion, argumentation, and reflection.

Findings by van Hooijdonk et al. (2020) show that the stages of CPS, such as fact-finding, problem-finding, and solution-finding, provide students with opportunities to identify important information, formulate problems, and propose various alternative solutions. These activities directly encourage students to communicate their thoughts systematically, both verbally and in writing. These findings suggest a tendency for mathematical communication to develop optimally when students are given the space to explore various possible solutions rather than simply following teacher-determined procedures.

A similar trend is seen in research by Murwaningsih and Fauziah (2020), which shows that CPS contributes to improving students' divergent thinking skills. Divergent thinking skills enable students to generate various problem-solving strategies, which then need to be explained and discussed with classmates. In this process, mathematical communication plays a crucial role, as students must articulate their reasoning, solution steps, and relationships between mathematical concepts clearly and logically. These findings indicate that the development of mathematical communication in CPS is inseparable from students' ability to generate and develop creative ideas.

Subsequent research developments have shown that CPS is beginning to be integrated with various other mathematical skills. Tambunan (2021) and Rachman and Rosnawati (2021) found that CPS not only improves mathematical communication but also students' mathematical reasoning and self-esteem. This integration of communication, reasoning, and self-confidence indicates that the trend in CPS use is moving toward a more holistic learning approach. Students are not only trained to obtain correct answers but also to explain the rationale behind their chosen solutions and defend their arguments in discussion forums.

Simbolon's (2022) study further reinforces this trend by demonstrating that CPS effectively improves mathematical communication skills through the activity of evaluating various alternative solutions. This evaluation process requires students to present logical reasoning, compare different strategies, and communicate their thinking using appropriate mathematical representations. Thus, mathematical communication emerges not only as a final learning outcome but also becomes an integral part of every stage of the problem-solving process.

A more recent trend is evident in research by Sukmawati and Kaigere (2024) and Septiani and Hidayati (2024). Both studies demonstrate that CPS can accommodate diverse student characteristics through open-ended problem-solving activities. This approach allows students to develop various solution strategies, which are then communicated through discussions, presentations, and mathematical representations. These findings indicate that CPS is increasingly developing as a flexible and adaptive learning model to meet the needs of 21st-century students.

Pramesti and Mardaningtyas's (2025) research points to a further development, namely the integration of CPS with self-regulated learning skills. The results showed that students with strong self-regulation skills tended to be better able to organize ideas, explain solution strategies, and reflect on the mathematical arguments presented. These findings indicate that the trend in CPS research is beginning to move toward the development of mathematical communication that is influenced not only by learning models but also by students' internal factors.

Overall, research trends for the 2020–2025 period indicate that CPS has evolved into a learning model that places mathematical communication as one of the key competencies to be developed. This development reflects the shift in orientation of modern mathematics education, which emphasizes not only the ability to calculate and solve problems but also the ability to explain, argue, collaborate, and reflect effectively on mathematical thinking processes.

The Effectiveness of Applying the Creative Problem Solving (CPS) Model on Mathematical Communication Skills

Theoretically, the effectiveness of Creative Problem Solving (CPS) in improving mathematical communication skills. The results of the literature synthesis indicate that the Creative Problem Solving (CPS) model has consistent effectiveness in improving students' mathematical communication skills. This effectiveness can be explained through the characteristics of CPS which position students as active subjects in the learning process through activities to identify problems, explore various alternative solutions, evaluate the strategies used, and communicate the results of their thinking systematically. In each stage of CPS, students are not only required to find the correct answer, but also to explain reasons, defend arguments, and present solutions using

appropriate mathematical representations. This condition makes mathematical communication an integral part of the problem-solving process, not just the end result of learning. This finding is in line with research by Tambunan (2021) which shows that CPS has a significant effect on improving mathematical communication and reasoning skills because it encourages students to develop ideas and convey mathematical thinking in a more structured manner. In addition, research by Sukmawati and Kaigere (2024) also shows that students who learn using CPS have better mathematical communication skills than students who follow conventional learning.

Based on the synthesis results, all the analyzed studies show that students who learn using CPS tend to be better able to explain problem-solving procedures, connect mathematical concepts, and use various mathematical representations such as symbols, tables, diagrams, and graphs more appropriately. These findings indicate that CPS provides students with broader opportunities to organize and construct mathematical ideas before communicating them to others. These results are supported by research by Amany et al. (2024) who found that mathematical communication skills develop when students engage in problem-solving activities that require strategic explanations, argument validation, and logical presentation of solutions. Research by Erviana et al. (2025) also confirms that mathematical communication is an important part of higher-order thinking skills because it helps students connect their thinking processes with the mathematical representations used during problem solving. Thus, the effectiveness of CPS is not only seen in improved learning outcomes, but also in the quality of students' thinking processes and delivery of mathematical ideas.

The effectiveness of CPS is also evident in its ability to create a collaborative learning environment. The group discussion activities, a key characteristic of CPS, enable students to exchange ideas, respond to peers' opinions, and refine their understanding through an active communication process. The synthesis of results indicates that the social interactions that occur during the problem-solving process contribute to improving students' ability to use mathematical language more precisely and systematically. This finding is supported by research by Pramesti and Mardaningtyas (2025), which shows that the implementation of CPS encourages students to be more active in discussing, presenting ideas, and reflecting on solutions, thus optimally developing mathematical communication skills. In this context, mathematical communication does not develop solely through individual activities, but through the process of negotiating meaning and constructing knowledge collaboratively throughout the learning process.

Furthermore, CPS provides students with the opportunity to generate more than one alternative solution to a problem. This characteristic is an important factor that distinguishes CPS from conventional learning, which is generally oriented towards a single correct answer. When students generate various solution strategies, they are encouraged to explain the advantages and disadvantages of each strategy, compare the effectiveness of the solutions obtained, and defend arguments supporting their choices. This process directly trains mathematical communication skills because students must organize ideas, construct logical reasoning, and convey arguments clearly. This finding is in line with research by Saputra et al. (2024) which shows that CPS can develop mathematical creative thinking skills through activities exploring various alternative solutions. The results of research by Hasanah et al. (2024) also show that mathematical

communication skills are closely related to problem-solving abilities, mathematical reasoning, and students' self-efficacy.

Analysis of all synthesized studies indicates that the success of CPS in improving mathematical communication skills is not solely due to the use of a particular learning model, but rather to the high level of student engagement in the communication process during problem solving. The more opportunities given to students to explain ideas, put forward arguments, evaluate solutions, and reflect on their thinking processes, the greater the improvement in mathematical communication skills they achieve. These findings suggest that mathematical communication develops as a consequence of the creative, reflective, and collaborative thinking activities facilitated by CPS. Thus, the effectiveness of CPS lies in its ability to integrate creative thinking, problem solving, communication, argumentation, and reflection into a series of mutually supportive learning processes. Overall, the results of the synthesis strengthen the position of CPS as a relevant learning model to support the development of mathematical communication skills while addressing the demands of 21st-century mathematics learning that emphasizes creativity, collaboration, communication, and problem-solving skills.

Practical Implications for Mathematics Education and Mathematical Communication

The results of the literature synthesis indicate that the application of Creative Problem Solving (CPS) has important implications for the development of mathematics learning in schools. The analyzed research findings consistently show that improvements in mathematical communication skills occur when students are given the opportunity to actively engage in the problem-solving process, discussion, argumentation, and reflection on the solutions obtained. Therefore, mathematics learning needs to be directed not only at achieving correct answers, but also at developing students' abilities to explain their thinking processes, put forward reasons, and communicate mathematical ideas orally and in writing. This implication suggests that mathematical communication should be viewed as an integral part of the mathematics learning process, not simply an outcome measured at the end of the learning process.

From a curriculum perspective, the synthesis results indicate that mathematical communication skills need to be positioned as one of the core competencies systematically developed in mathematics learning. This finding is relevant to the demands of 21st-century learning, which emphasizes mastery of communication, collaboration, creativity, and problem-solving skills as essential competencies for students. In this context, CPS can be a strategic pedagogical alternative because it is able to integrate creative thinking, mathematical communication, collaboration, and problem-solving activities in a series of mutually supportive learning processes. Thus, the implementation of CPS has the potential to support the achievement of curriculum objectives oriented towards the development of 21st-century competencies.

For teachers, the synthesis results indicate that the success of CPS implementation is strongly influenced by the quality of problem-solving activities provided to students. Therefore, teachers need to design open-ended and contextual problems to allow for the emergence of various problem-solving strategies. Furthermore, teachers also need to create a learning environment that supports discussion, argumentation, and reflection so that students feel safe and confident in expressing their mathematical ideas. These findings indicate that the role of teachers in CPS is no longer

as the primary source of information, but as facilitators who help students build mathematical understanding through meaningful interaction, exploration, and communication.

Overall, the synthesis results indicate that CPS is not only effective in improving problem-solving skills but also has the potential to build a culture of active, creative, collaborative, and sustainable mathematical communication in mathematics learning. Therefore, CPS can be considered as a relevant learning model to support the transformation of mathematics learning towards a more student-centered approach oriented towards the development of 21st-century competencies.

CONCLUSION

Based on the synthesis of findings from various reviewed studies, it can be concluded that the Creative Problem Solving (CPS) learning model has a significant contribution in improving students' mathematical communication skills. Through systematic problem-solving stages, starting from problem identification, idea development, solution selection, and solution implementation, CPS provides opportunities for students to express ideas, explain solution strategies, convey arguments, and use various mathematical representations more effectively. Discussion activities, idea exploration, and solution evaluation, which are the main characteristics of CPS, also encourage the development of mathematical communication skills both orally and in writing. Thus, CPS not only helps students find solutions to a mathematical problem, but also builds their ability to communicate their thinking processes logically, systematically, and meaningfully.

Although most studies demonstrate the effectiveness of CPS in improving mathematical communication skills, this review also identified several limitations. Most of the studies analyzed used short-term experimental designs and were conducted on relatively limited sample sizes, so generalizing the results to various educational contexts still requires further study. Furthermore, differences in student characteristics, educational level, quality of CPS model implementation, and mathematical communication measurement instruments have the potential to influence variations in results obtained across studies. Therefore, further research is recommended to:

1. Conducting a longitudinal study to examine the long-term impact of implementing Creative Problem Solving on the development of students' mathematical communication skills.
2. Exploring the effectiveness of CPS at different levels of education, student characteristics, and cultural contexts to gain a more comprehensive understanding.
3. Integrating educational technologies, such as interactive digital media, online collaborative platforms, and artificial intelligence-based learning systems, to support the implementation of CPS in developing students' mathematical communication.
4. Examining the relationship between Creative Problem Solving and other variables such as creative thinking skills, problem-solving skills, self-regulated learning, and mathematical self-confidence in order to obtain a more complete picture of the factors that influence mathematical communication.

Overall, the results of this study confirm that Creative Problem Solving (CPS) is not simply a problem-solving-oriented learning model, but also an effective pedagogical approach in developing students' mathematical communication skills. Through learning that emphasizes creativity, argumentation, collaboration, and reflection, students not only gain a deeper understanding of mathematical concepts but also develop essential communication skills to face the demands of learning and life in the 21st century.

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