UJMER Volume 2 Nomor 1 2024

Unnes Journal of Mathematics Education Research

http://journal.unnes.ac.id/sju/index.php/ujmer

Literature Study: Mathematical Metacognition Ability in Terms of Self-Efficacy in The PBL Model

Nisrina Fatin[1]✉, Iwan Junaedi, Bambang Eko Susilo

UNNES, Semarang, Indonesia

Article Info

Article History:
Received 15 March 2024
Accepted 26 April 2024
Published 28 Juni 2024

Keywords:
Mathematical metacognition, Problem based learning, Self-efficacy.

Abstract

Learning mathematics requires good metacognition skills to solve problems through a series of critical, rational, and logical thinking activities. Students' lack of understanding and confidence during the learning process shows the importance of self-efficacy. The problem-based learning model helps students' thinking process in solving problems with confidence in their abilities. This study aims to analyze, review, and draw conclusions from the literature relevant to mathematical metacognition skills in terms of self-efficacy in problem-based learning models. The literature study method was used to review previous journal articles as the main reference source relevant to students' mathematical metacognition skills in terms of self-efficacy in PBL models. Based on the research results, it can be concluded that students' mathematical metacognition ability and self-efficacy in problem-based learning (PBL) model learning have a relationship with each other whereas mathematical metacognition ability affects students' self-efficacy. Students with high mathematical metacognition skills will have good self-efficacy and vice versa.

✉Correspondence Address:
UNNES, Semarang, Indonesia
E-mail: nisrinafatin456@students.unnes.ac.id

p-ISSN 2252-6455
e-ISSN 2502-4507

INTRODUCTION

Education currently requires students to develop several skills, namely the 4C Skill which consists of Communication, Critical Thinking & Problem Solving, Collaboration, and Creative & Innovative. These skills need to be developed so that students have skills in problem solving, critical thinking, metacognition, collaboration, communication, innovation, creativity, and literacy (Milchatin Noor & Amidi, 2024). The problem of lack of mastery of methods, learning approaches, and the use of teaching materials in accordance with mathematics material at each grade level is a problem in learning mathematics today (Susiani, 2021). This causes students to have difficulty in understanding mathematics material and showing their academic achievement optimally as expected.

Mathematical problem solving ability is influenced by several factors, one of which is metacognition (Nursaodah et.al., 2024). Flavell stated that metacognition comprises rules, experiences, and knowledge that function as essential elements and contribute to successful problem-solving. Metacognition is an advanced cognitive capacity that may be linked to consciousness and self-awareness (Koriat, 2007; Smith et al., 2016). Desmita (Safitri et al., 2020) also states that metacognition is knowledge and awareness of cognitive processes, or knowledge about the mind and how it works. Finally, according to Wilson and Conyers (Zega, 2021), individuals can use their existing knowledge to control their cognitive abilities, thus achieving learning objectives. According to the results of research conducted by Nursaodah, et.al. (2024) said that students with high metacognition skills will have better problem solving skills compared to students who have low metacognition skills and vice versa. Previously, this was also revealed by Stillman & Mevarech (2010), who reported findings indicating that students with metacognitive training performed significantly better in problem-solving tasks than untrained students.

Mathematical metacognition is an individual's ability to monitor their thought processes, such as when solving mathematical problems. This includes trying different approaches, evaluating the potential success of specific strategies, and so on. Mathematical metacognition plays a unique role in cognitive regulation. This was highlighted by Rambe et al. (2020), who stated that problem-solving is a component of metacognition that has a distinct role in the mathematics learning process. Based on this, Pathuddin & Bennu (2021) also expressed a similar view, stating that integrating mathematical metacognition into various activities has proven beneficial. For instance, it can enhance problem-solving abilities, aid reading comprehension, improve learning outcomes, or help students become successful learners. Indeed, incorporating metacognition into various learning activities provides benefits for enhancing the quality of learning. Thus, the role of teachers is very important in developing students' mathematical metacognition skills, one of which is by implementing problem-solving-based mathematics learning.

Mathematical problem solving ability is also influenced by student self- efficacy. Subaidi (2016) states that students with high self-efficacy will be more resilient in facing mathematical problems, while students with low self-efficacy will tend to be vulnerable and easily give up when encountering such problems. This is because in solving problems, students are often faced with problems about feelings of confidence and doubt in their abilities both to start and the results they get (Wahyudi et.al., 2021). According to Ormrod (Moma, 2014), several factors influence the development of self-efficacy: (a) Students' previous successes and failures: This means students are more likely to succeed in a task if they've had success in similar tasks in the past; (b) Messages from others: Educators, for instance, can give students reasons to be more confident and believe in their future success; (c) Others' successes and failures: This significantly impacts students' self-belief. For example, if a student sees another student succeed in math, they'll likely feel they can also succeed. Conversely, if another student fails, they might feel they will too; (d) Group success and failure: If students perceive that they can work together effectively and coordinate their roles and responsibilities, they'll have strong self-belief in achieving that success.

While Susiani (2021) states problems faced in learning mathematics today cause students to be unable to show their academic achievement optimally according to their abilities. Students often feel unsure that they will be able to complete every task assigned by the teacher to them. This lack of hope or belief possessed by students is an indication of low self-efficacy or self-efficacy in learning mathematics at school. Good self-efficacy allows students to realize the limits of their abilities in the learning process so that they can complete tasks optimally.

According to Wahyudi, et.al. (2021) self-efficacy can influence action, effort, perseverance, and flexibility in the differences and realization of each individual's goals. High and low self-efficacy are often influenced by environmental factors, so a responsive environment is considered capable of creating greater success for student development. Learning that can develop self-efficacy in mathematics learning focuses on training students' metacognition (Susiani, 2021). This is because in learning students can assess the difficulty of a problem, can observe their self-awareness of how they learn, the ability to level their understanding, the ability to use various information to achieve goals, and the ability to assess their learning. In essence, metacognitive activity is an activity of conscious control of the cognitive process itself (Rodli & Widiastutik, 2024). Therefore, according to Rodli and Widiastutik (2024) one must continue to learn, have the ability to evaluate the difficulty of a problem, have the ability to observe their level of understanding, the ability to use various information to achieve goals and the ability to evaluate material learning progress.

Students' metacognition ability during the learning process can improve learning achievement, because children have planned, understood their development, and realized their learning needs. Students' mathematical metacognition supported by self-efficacy is needed to develop motivation in completing tasks, being independent of learning outcomes, being honest, and following learning well. Low student self-efficacy in mathematics learning results in difficulties in analyzing phenomena around. Learners need to increase self- efficacy to understand mathematical concepts to be applied in the process of problem orientation, organize themselves in learning, conduct investigations, develop and present results, and analyze and evaluate problem solving. This study aims to determine how students' mathematical metacognition skills are viewed from students' self-efficacy in problem-based learning (PBL). By considering previous research related to the topic of study, this research will examine several journal articles using systematic literature review.

METHOD

This research uses a qualitative approach to explore the phenomenon of complex and diverse problems. The type of literature study research using the Systematic Literature Review (SLR) method is a technique for identifying, synthesizing, and evaluating evidence relevant to research needs. The literature study technique was carried out by searching for several journal articles in various reputable journals both indexed scopus and google scholar, then conducting in-depth identification and review. The keywords in the article search focused on students' mathematical metacognition skills in terms of self-efficacy in the problem-based learning model.

The use of the literature study method aims to collect, analyze, report, and evaluate previous journal articles related to students' mathematical metacognition ability in terms of self-efficacy in problem-based learning model. The steps of the literature study are carried out by researchers, namely the process of planning, identification, selection, evaluation, data extraction, synthesis, presentation, verification, and updating. Data analysis is carried out by combining all relevant data, and then writing descriptively so that the problem description can be explained according to the research question. The following are some reference sources that will be reviewed in this study in the form of research journal articles related to students' mathematical metacognition abilities

in terms of self-efficacy in the PBL model, including the following.

Table 1. Reference Sources

No.	Research Title	Researcher	Year
1	Analysis of Metacognition Skills in Solving Mathematical Connections of Trigonometry Material in View of Self- Efficacy of Class XI Students of SMAN 4 Kendari	Dahlan Wahyudi, Mustamin Anggo, La Misu	2021
2	Training Students' Metacognition in Developing Self-Efficacy in Math Learning	N. Eri Susiani	2021
3	Mathematical Problem Solving Ability in View of Self-Efficacy: A Systematic Literature Review (SLR) in Indonesia	Aulia Adytia Putri, Dadang Juandy	2022
4	Problem Based Learning (PBL) Model with STEAM Approach as an Effort to Increase Learning Activity	Ratna Sari, Sawitri Komarayanti, An Rini Mudayanti	2023
5	Enhancing Thai Student-Teacher Problem- Solving Skills and Academic Achievement Through a Blended Problem Based Learning Approach in Online Flipped Classrooms	Paitoon Pimdee, Aukkapon Sukkamart, Cherisa Nantha, Thiyaporn Kantathanawat, Punnee Leekitchwatana	2024
6	Mathematical Problem Solving Ability in View of Students' Metacognition Through Problem Based Learning with Open Ended Problems Assisted by Sevima Edlink	Nursaodah, Emi Pujiastuti Kristina Wijayanti	2024
7	Improved Learning Outcomes Through Problem Based Learning Model	Devi Widyasari, Noor Miyono, Susilo Adi Saputro	2024
8	The Effect of Metacognitive Strategies on Self-Efficacy and Problem Solving of MAN 2 Mojokerto Students	Moh. Rodli & Trisya Widiastutik	2024

RESULTS AND DISCUSSIONS

Metacognitive ability is a person's ability to control the learning process he goes through starting from the planning stage, choosing the right strategy according to the problem at hand, then monitoring progress in learning and simultaneously correcting if there are errors that occur while understanding concepts, analyzing the effectiveness of the chosen strategy, then reflecting in the form of changing learning habits and strategies if it is deemed no longer suitable for the needs of his environment (Susiani, 2021) . So, metacognition is developed through a person's thought process regarding the behavior they do. The role of the teacher is very important in developing students' mathematical metacognition skills, one of which is by implementing problem-solving-based mathematics learning. Teachers can act as facilitators who provide direction and guidance through questions that can lead and direct students to the right steps and solutions by presenting problems, asking questions, and facilitating investigation and dialog during the learning process.

Problem Based Learning (PBL) is one form or model of learning that focuses on the constructivism paradigm which is oriented toward the learning process of students or student-centered-learning. This learning is one of the lessons that can stimulate students to have the skills needed in the 21st century, namely critical thinking, creativity, collaboration, and communication. This learning essentially presents a contextual or non-contextual problem to students, then students are assigned to solve the problem together or in groups with the teacher as a facilitator and mentor (Sari, Komarayanti, and Mudayanti, 2023). According to Pimdee, Sukkamart, and Nantha (2024) learning problem-based learning model is an important learning innovation to respond to the problems of today's students. Meanwhile, according to Widyasari, Miyono, and Saputro (2024) the advantages of problem-based learning model learning include (1) making it easier to understand the material for students, (2)

increasing students' knowledge through exploring new concepts, (3) encouraging active involvement in the learning process, (4) helping students apply knowledge in real-life situations, and (5) developing critical thinking skills and improving student skills.

According to the results of research conducted by Nursaodah, Pujiastuti, and Wijayanti (2024) said that students' mathematical problem solving ability is influenced by their mathematical metacognition ability. Based on the results of the study, students' mathematical problem solving ability is directly proportional to their mathematical metacognition ability, meaning that students with high mathematical metacognition ability will have high mathematical problem solving ability and vice versa. Students with high metacognition category are optimal in applying the four indicators of problem solving ability, but less optimal in interpreting the results of problem solving. Then, students with moderate metacognition are optimal in solving mathematical problems on the indicator of choosing problem strategies, quite optimal in applying indicators of formulating problems, applying problem solving strategies, and solving mathematical problems in various ways, and less optimal in applying indicators of interpreting problem solving results. Furthermore, students with low metacognition are quite optimal in solving mathematical problems on indicators of formulating problems and choosing problem solving strategies, and less optimal on indicators of applying problem solving strategies, solving math problems in various ways, and interpreting problem solving results. Thus, it can be concluded that students' metacognition ability is directly proportional to their problem solving ability.

Problem-solving-based learning such as PBL will be able to condition students in getting used to investigating and discovering something (Susiani 2021). According to Susiani (2021) specifically, the problem-solving approach is the focus in learning mathematics by the expected basic competencies. As viewed from the aspect of competence to be achieved, mathematics subjects emphasize mastery of concepts and algorithms in addition to mathematical problem solving skills. This means that students' success in solving mathematical problems depends on students' awareness of what they know and how they apply it, this is what is called metacognition. So, metacognition has a very important role in regulating and controlling one's thought process in learning and thinking.

Given the important role of metacognition in successful learning, efforts to improve student learning outcomes can be made by improving metacognition (Rodli and Widiastutik 2024). Developing metacognition is improving a person's thought process to control what he thinks, what he does about the given task whether it has met the demands requested from the task or not (Susiani 2021). The link between metacognition skills and thinking strategies is that metacognition skills provide a way to direct and control the thinking process to produce critical thinking skills in solving problems (critical thinking). According to Rodli and Widiastutik (2024) one's success in learning is influenced by various factors, one of which is metacognition, so that if every activity in learning is carried out by referring to indicators of how to study, maximum results will be easily achieved.

One of the urgencies of developing students' mathematical metacognition skills is increasing students' self-efficacy. Self-efficacy or self-efficacy is a person's belief about his ability to overcome various situations that arise in his life and is not related to the skills possessed but rather to individual beliefs about what his skills can do (Susiani, 2021) . A person with high self-efficacy will make him more confident in himself to do something that can change the circumstances around him and has tends to always try hard in the face of all challenges. Conversely, someone with low self-efficacy will think that he will not be able to do anything and has tends to give up easily. So, self-efficacy is not how much ability a person has but how much confidence the person has to complete the task.

Mathematical metacognition ability and self-efficacy have a relationship with each other, this is because both can affect students' mathematical problem solving ability (Putri and

Juandy 2022) . According to the results of research conducted by Putri and Juandy (2022) said that the higher the self-efficacy or self-efficacy possessed by students, the higher the mathematical problem solving ability they have and vice versa. According to Susiani (2021) by training students' metacognition, students' confidence in doing each task (self-efficacy) in learning mathematics will continue to increase. Students with high self-efficacy are characterized by having a positive view of the tasks they face and the belief that they can complete their tasks well, have strong motivation to complete tasks as their responsibility, and try to find effective solutions to solve the tasks they face. This is also supported by the results of research conducted by Wahyudi, Anggo, and Misu (2021) said that someone with a high self-efficacy category involves metacognition skills in solving math problems, while someone with a low self-efficacy category does not all involve metacognition skills in solving math problems.

The relationship between mathematical metacognition ability and student self-efficacy has also been tested quantitatively. One of them is the results of research conducted by Rodli and Widiastutik (2024) which says that metacognitive learning strategies applied to students show good results in self- efficacy when compared to students who do learning using only cognitive strategies. Then the significance value which is less than 0.05 indicates that the metacognitive strategy has a significant effect on self-efficacy (Rodli and Widiastutik 2024) . Therefore, in learning that applies metacognitive strategies such as problem-based learning (PBL), teachers play an important role in terms of intervening with students through metacognitive instructions so that students become confident and confident in solving the problems they face in learning.

Research results from several previous studies show that mathematical metacognition skills in terms of self-efficacy in problem-based learning (PBL) models are developed to develop confidence in personal abilities to overcome problems. Positive self-efficacy owned by students dominates the success of mathematical problem solving, especially in the application of the PBL model as a stimulus and practice to link mathematical concepts and problems in the surrounding environment. Good self-efficacy has a significant impact on students' confidence in completing tasks from mild to severe levels. Students with high self-efficacy tend to have good mathematical metacognition skills indicated by responsibility, thoroughness, and motivation in completing tasks. Meanwhile, students with low self-efficacy are not optimal in receiving stimulus, managing learning, establishing cooperation, and expressing arguments related to problem solving during the learning process. The PBL model, which is expected to build students' knowledge through the process of problem recognition, investigation, data development, presentation of results, and analysis and evaluation, is closely related to students' mathematical metacognition skills in terms of self-efficacy.

Some previous studies used more quantitative approaches, because data analysis through calculations by entering certain formulas can produce statistical data that is systematic, detailed, and objective. However, the qualitative approach is also used to describe the findings according to field data without the need to conduct statistical tests. After collecting and analyzing data according to the research topic, it can be understood that each step of the problem-based learning (PBL) model can help students to develop critical thinking skills independently and in groups. The presentation of problems during the data collection process until the evaluation provides an opportunity for students to show good self- efficacy. Thus, students' mathematical metacognition ability can be improved through the application of PBL to create an inclusive learning environment and motivate students to believe in their abilities.

CONCLUSION

This research has explored mathematical metacognition ability in terms of self-efficacy in problem-based learning (PBL) model. Based on this analysis, it was found that the PBL model is one of the learning that applies metacognitive strategies and can improve students' mathematical problem solving skills.

Mathematical metacognition ability and student self-efficacy in PBL model learning have a relationship with each other where mathematical metacognition ability will affect student self-efficacy. Students with high mathematical metacognition ability will have good self-efficacy and vice versa. This is also supported by the results of research conducted by Wahyudi, Anggo, and Misu (2021) said that someone with a high self-efficacy category involves metacognition skills in solving math problems, while someone with a low self- efficacy category does not all involve metacognition skills in solving math problems.

This research analysis is supported by Rodli and Widiastutik (2024) which says that metacognitive learning strategies applied to students show good results in self-efficacy when compared to students who do learning using only cognitive strategies. In addition, a significance value of less than 0.05 indicates that metacognitive strategies have a significant effect on self-efficacy. Overall, this study makes an important contribution in understanding the phenomenon of mathematical metacognition ability in terms of self-efficacy in problem-based learning model. These findings are expected to be a guide for educators, researchers, and policy makers to design problem-based mathematics learning strategies that are relevant to future needs. Thus, students have positive self- efficacy in developing mathematical metacognition skills as independent, critical, creative, and responsible learners.

REFERENCES

Milchatin Noor, Auliya, and Amidi. 2024. "Literature Study: Students' Mathematical Problem Solving Ability in View of Self Efficacy in the Team Assisted Individualization Model." *PRISMA: Proceedings of the National Seminar on Mathematics* 7 (2): 137-49.

Moma, L. (2014). Self-Efficacy Matematik Pada Siswa SMP. *Jurnal Pendidikan Matematika*, 3(2), 88-89.

Nursaodah, Emi Pujiastuti, and Kristina Wijayanti. 2024. "Mathematical Problem Solving Ability Viewed from Student Metacognition Through Problem Based Learning with Open Ended Problems Assisted by Sevima Edlink." *Cendekia Journal: Journal of Mathematics Education* 08 (01): 189–203.

Pathuddin, & Bennu, S. (2021). Metacognitive skills of students with high mathematical abilities in solving contextual problems. *Journal of Physics: Conference Series*, *1832*(1).

Pimdee, Paitoon, Aukkapong Sukkamart, and Cherisa Nantha. 2024. "Enhancing Thai Student-Teacher Problem-Solving Skills and Academic Achievement Through a Blended Problem-Based Learning Approach in Online Flipped Classrooms." *Heliyon* 10: 1–19.

Putri, Aulia Adytia, and Dadang Juandy. 2022. "Mathematical Problem Solving Ability in View of Self Efficacy: Systematic Literature Review (SLR) in Indonesia." *Symmetry: Pasundan Journal of Research in Mathematics Learning Education.* 7 (2): 135–47.

Rambe, K. N., Sinaga, B., & Asmin, A. (2020). Analisis Kemampuan Metakognisi Dalam Pemecahan Masalah Matematis Pada Pembelajaran Berbasis Masalah Ditinjau Dari Gaya Belajar. *Paradikma: Jurnal Pendidikan Matematika*, *13*(2), 1–17.

Rodli, Moh., and Trisya Widiastutik. 2024. "The Effect of Metacognitive Strategies on Self-Efficacy and Problem Solving of MAN 2 Mojokerto Students." *Edu Cendekia: Scientific Journal of Education* 4 (02): 260–68.

Safitri, P. T., Yasintasari, E., Putri, S. A., & Hasanah, U. (2020). Analisis Kemampuan Metakognisi Siswa dalam Memecahkan Masalah Matematika Model PISA. *Journal of Medives : Journal of Mathematics Education IKIP Veteran Semarang*, *4*(1), 11.

Sari, Ratna, Sawitri Komarayanti, and An Rini Mudayanti. 2023. "Problem Based Learning (PBL) Model with STEAM Approach as an Effort to Increase Learning Activity." *Publising: Journal of Biology* 1 (2): 1–10.

Smith, J. D., Zakrzewski, A. C., & Church, B. A. (2016). Formal models in animal-metacognition research: the problem of

interpreting animals' behavior. *Psychonomic Bulletin and Review*, *23*(5), 1341–1353.

Stillman, G., & Mevarech, Z. (2010). *Metacognition research in mathematics education : from hot topic to mature field*. 145–148.

Subaidi, A. (2016). Self-Efficacy Siswa Dalam Pemecahan Masalah Matematika. ∑*Igma*, *1*(2), 64–68.

Susiani, N. Erni. 2021. "Training Students' Metacognition in Developing Self-Efficacy in Mathematics Learning." *EDUCATOR: Journal of Innovation for Educators and Education Personnel* 1 (1): 31–38.

Wahyudi, Dahlan, Mustamin Anggo, and La Misu. 2021. "Analysis of Metacognition Skills in Solving Mathematical Constructions on Trigonmetry Material in View of Self-Efficacy of Class XI Students of SMAN 4 Kendari." *Journal of Mathematical Thinking Learning* 6 (1): 30–46.

Widyasari, Devi, Noor Miyono, and Susilo Adi Saputro. 2024. "Improving Learning Outcomes Through Problem Based Learning Model." *JIEPP: Journal of Learning Innovation, Evaluation, and Development* 4 (1): 61–67.

Zega, Y. (2021). *Hubungan Metakognitif Dan Self Efficacy Terhadap*. *15*(April), 2563–2572.