



The Role of Self-Efficacy in Enhance Metacognitive and Academic Performance Through Problem-Solving

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ABSTRACT

This research analyzes the role of self-efficacy in enhancing metacognitive and academic performance of students through problem-solving as learning process. Researchers research some students from senior high school in Malang. This research uses mixed methods with surveys, interviews, and analysis of students' learning outcomes. At the first meeting, students were asked to fill survey about the dimensions of self-efficacy, which are magnitude, strength, and generality. Moreover, researchers interviewed students to explore their metacognitive activities that they do, such as awareness, regulation, and evaluation. After that, researchers analyze their learning outcomes to determine their academic performance. This research result shows that students with a high dimension of self-efficacy tend to show better metacognitive activity than the other. Furthermore, students with a high dimension of self-efficacy tend to show better academic performance than others.

Keywords: academic performance; metacognitive activity; problem-solving; self-efficacy

INTRODUCTION

Problem-solving skill is an important ability necessary by students. School institutions often suggest problem-solving skills as a measurement for academic success (Albay, 2020). This skill consists of problem identification, alternative invention, analysis answer, and implementation of the best solution. One of the best ways to enhance problem-solving skills is to give problem-solving questions to students (Pimdee et al., 2024). Mathematical learning models with problem-solving can help students to extend their cognitive comprehensively (Sormin & Pasaribu, 2023). However, students are not accustomed to solving problem questions. They find it difficult to define the problem, outline alternatives, and analyze the best solutions (Mabansag, 2024). Students tend to use a method that ensures finding one correct answer from several possible answers (Walida et al., 2022)

Problem-solving skills are related to metacognitive and self-efficacy. Many researchers stated that metacognition is related to problem-solving (Faoziah et al., 2023; Güner & Erbay, 2021). Students with high metacognitive will solve problems better than others. By understanding metacognitive, students will easily determine the objectives of the problem, outline possible strategies, and determine the best solution to solve the problem.

Self-efficacy also demonstrates a positive relation to problem-solving (Aurah et al., 2014; Kozikoğlu, 2019). Students with high self-efficacy will find it easier to work on problem-solving questions. Self-efficacy will make students more resilient in solving questions that take a long time, confident in solving difficult problems, and always seeking other methods in more effective ways.

Researchers use academic performance as the output of metacognitive and self-efficacy. Metacognitive and self-efficacy have a positive effect on academic performance. The higher metacognitive and self-efficacy of students, the higher their academic performance will be.

In general, researchers discuss metacognitive and self-efficacy as a unified concept, and there are still few who discuss aspects of metacognitive or self-efficacy as predictors of academic performance. Researchers use metacognitive activity from Magiera & Zawojewski in Firmansyah et al., (2022) which consists of awareness, regulation, and evaluation. Meanwhile, for self-efficacy, researchers use three dimensions of self-efficacy from Bandura (1997) which consist of magnitude, strength, and generality (Monika & Adman, 2017). Therefore, the aim of this research is to describe the role of student self-efficacy in strengthening metacognitive and academic performance using problem-solving questions.

The main concept of self-efficacy revolves around experiences and psychological conditions. Self-efficacy is an individual's belief in their competence to solve problems and achieve goals (Regier & Savic, 2020). Bandura (1997) identifies four sources that can influence self-efficacy: individual successful experiences, observing others' experiences, social persuasion, and psychological and emotional states (Mawaddah, 2019). Students with more successful experiences will demonstrate higher levels of self-efficacy.

Researchers use three dimensions of self-efficacy from Bandura: magnitude/level, generality, and strength (Monika & Adman, 2017). Magnitude refers to an individual's belief in their ability to tackle difficult tasks. The higher the magnitude, the more confident the person is in their ability to solve difficult problems. Generality pertains to the extent of someone's perceived self-efficacy across various situations. The higher the generality, the more they believe they can accomplish anything. Lastly, strength denotes how steadfastly someone sticks to their decisions. Individuals with high strength will persevere in tasks they're working on, even if they are long or exhausting.

Metacognitive refers to thinking about thinking and knowledge about cognitive phenomenon (Fitri, 2017). Furthermore, metacognitive is an individual's awareness of how they learn, assess difficulties in problems, evaluate their level of understanding, utilize information to achieve goals, and evaluate the learning process (Suhandoko & Hsu, 2020). With metacognition, students can oversee and control their learning process (Laamena & Laurens, 2021). With these abilities, students are able to achieve better academic performance.

Researchers use metacognitive activity which consists of awareness, regulation, and evaluation (Firmansyah et al., 2022; Purnomo et al., 2016). Awareness involves students' consciousness in the problem-solving process, their knowledge, and their understanding related to learning or problem-solving process. Regulation occurs when students utilize their metacognitive abilities to plan, set goals, determine actions to be taken, or choose new actions. Lastly, evaluation is the student's assessment of their thought process, thinking abilities, limitations, and the difficulties they encounter (Dethan et al., 2024).

Many researchers have indicated a positive relationship between self-efficacy and metacognition, where students with high self-efficacy tend to have better metacognitive (Nurjanah et al., 2021). Students with high self-efficacy tend to: (1) perceive challenges as opportunities for growth, (2) view failures as controllable and improvable variables, and (3)

quickly recover from failures by exerting more effort for better outcomes (Peacock et al., 2020). Furthermore, students with high self-efficacy tend to be more effective in utilizing the necessary information to regulate the learning process (Alamudin et al., 2022; Cho et al., 2017). Students with high self-efficacy will utilize metacognitive skills more effectively and work harder to complete tasks (Gurat & Medula, 2021). Thus, self-efficacy has a positive influence on metacognitive.

Academic performance measures the success of students in the learning process (Supervía et al., 2022). Performance is a multi-dimensional concept, depending on the targets and expected outcomes. Researchers divide performance into two categories based on how it's measured: first, quantitatively and target-based, and second, qualitatively and subjectively assessed. Researchers use quantitative assessment.

Many researchers identify a relationship between self-efficacy and academic performance, where students with high self-efficacy tend to have high academic performance as well (Feldman & Kubota, 2015; Grigg et al., 2018; Herlina et al., 2022; Honicke & Broadbent, 2016; Suherman et al., 2018; Yanisa et al., 2022). Students with high self-efficacy tend to set high academic targets (Jayanthi et al., 2014), spend more time learning, and enjoy the learning process more than other students (Hakyemez & Mardikyan, 2021). Furthermore, students with high self-efficacy view challenges as opportunities to develop their academic abilities, motivating them to maximize their cognitive development (Zander et al., 2018). Thus, self-efficacy has a positive influence on academic performance.

RESEARCH METHODS

Researchers used a mixed-methods research approach to analyze the role of self-efficacy in relation to student metacognition and academic performance. Students employed semi-structured interviews, surveys, and analysis of student learning outcomes. The participants in this study consisted of 40 students from several high school schools in Malang, selected randomly.

The survey method is used to determine the self-efficacy of students. Researchers gave a self-efficacy questionnaire to 40 students, consisting of 20 statements, namely 11 positive statements and 9 negative statements. Statements 1-8 are about the magnitude dimension, statements 9-14 are about generality, and statements 15-20 are about strength. The questionnaire follows a Likert scale with four options: Strongly Agree (SA), Agree (A), Disagree (D), and Strongly Disagree (SD).

Furthermore, researchers will conduct interviews with 10 students to understand the students' metacognitive activities. Researchers will use Wilson's metacognitive card as a basis for the interview. Students can respond with "No," "Rarely," and "Often." Afterward, the researcher can develop further questions to ensure clarity about students' metacognitive processes.

Quantitative scores used on both available questions to measure academic performance. Each students were given independent scores by researchers. Then, the scores and answers would be compare to ensure objectivity in scoring. These student responses can also be used to clarify the metacognitive activities possessed by the students. These are the two questions given to students which have been translated into English.

1. Locker Game



Today, Tunas Bangsa School went swimming together in the school swimming pool. There are 2000 students who will swim. There are also 2000 lockers available there. Andi, the physical education teacher, creates a game. The first student enters the locker area and opens all the lockers. The second student closes the second locker and its multiples. The third student closes the locker if it is open or opens the locker if it is closed on the third locker and its multiples. The fourth student does the same as the third student on the fourth locker and its multiples, and so on until the 2000th student finishes. So, how many lockers are open?

2. Marbles



Andi has many marbles. These marbles are placed into boxes, with the same number in each box. It turns out that the number of marbles in one box is equal to the total number of boxes. However, because Andi's boxes are limited, there are still marbles left over. The remaining marbles are then placed into a triangular container with the same number. The number of marbles in one triangle is equal to the number of marbles in one box. It turns out there are 2 filled triangular containers and 2 marbles left over. Then Andi distributes all his marbles to his friends in equal amounts. The number of Andi's friends is equal to the number of marbles in one container plus 1. After distribution, it turns out that Andi still has marbles left. How many marbles are left for Andi?

Both problem-solving questions are considered capable of stimulating students' metacognitive activities. In addition, both questions function as considerations for assessing students' academic performance.

RESULT AND DISCUSSION

Researchers analyzed the self-efficacy data with a Cronbach's α value of 0.771. This indicates that the data used is reliable and suitable for the research. Below are the self-efficacy results for all research subjects.

Table 1. Result of Student Self-Efficacy ($n = 40$ cronbach $\alpha = .771$)

	Self-Efficacy		
	Magnitud e	Strengt h	Generalit y
High	6	6	5
Medium	27	29	26
Low	7	5	9
M(SD)	23.68(3.1 1)	18(3)	17(2.3)

Researchers randomly selected 10 students for interviews out of that 40 students. The selected students represent high, moderate, and low categories in each dimension of self-efficacy.

Table 2. Result of Student Self-Efficacy ($n = 10$)

	Self-Efficacy		
	Magnitud e	Strengt h	Generalit y
High	2	4	2
Medium	5	4	6
Low	3	2	2

Based on the interview results and the students' answer sheets, it's evident that students with high magnitude, strength, and generality demonstrate high awareness both in the first and second questions. When working on the first question, they reflect and become aware of the knowledge they need to answer the question, which is the knowledge about the characteristic of square numbers having an odd number of factors. Meanwhile, in the second question, they utilize their mathematical knowledge about division and remainders in dividing polynomials.

Students with low to medium magnitude and generality, demonstrate low awareness in both the first and second questions. This is because the students show little metacognitive awareness activities when solving the questions, despite reading the questions repeatedly and reflecting on what the students know about the questions. The students struggle to apply their mathematical knowledge effectively. On the other hand, students with low to medium strength show low awareness in the first question and medium awareness in the second question.

This is shown by the interview with students with low to medium magnitude and generality as follows.

- R : *“When working on this problem, have you ever thought that you have worked on a problem like this before?”*
 S1 : *“No, I immediately looked for a way that crossed my mind”*
 S2 : *“No, miss”*

This is shown by the interview with students with low to medium strength as follows.

- R : *“Have you ever thought that you have worked on a problem like this before?”*
 S3 : *“In the first question, I didn't think about it, but in the second question I tried to think of another question that might help me solve this”*

Students with high magnitude, strength, and generality, show medium evaluation on one problem and high evaluation on another. Specifically, students with high magnitude and generality demonstrate medium evaluation on the first problem and high evaluation on the second. This is evident as, when working on the first problem, students seldom evaluate students' answers, failing to discern the intended pattern, thus leading to an inability to solve the problem. This is further clarified during interviews, where students also acknowledge the limitations of their thinking abilities. However, on the second problem, students are able to evaluate the methods the students use, enabling them to solve the problem. This contrasts with what is observed in students with high strength, who show high evaluation on the first problem and medium evaluation on the second. This is shown by their frequent evaluation

of answers to the given problems, enabling them to solve problems. However, on the second problem, students seldom evaluate the methods and answers they provide, even though the solution may be correct, they are unable to complete it.

Students with low and medium magnitude, strength, and generality, demonstrate medium evaluation. This is due to their lack of assessment of the methods they employ, even though they can evaluate the limitations of their thinking abilities, resulting in their inability to solve the given problems, both in the first and second problems. This is shown by the interview with students low and medium magnitude, strength, and generality as follows.

R : "Did you check your answer again?"

SI : "No, because I already know that my answer is not quite right, because there is something I can't do when answering the question"

Students with high magnitude and generality, demonstrate medium regulation. This is evident when working on problems, students can plan, set goals, and determine the actions to be taken, allowing them to find the best strategies to solve the problems during the process.

Whilst high strength students, they show high regulation. This is demonstrated when working on problems, students can plan the use of strategies and understand the purpose and goals of the problems.

For students with low and medium magnitude, strength, and generality, they show low regulation. This is because students do not plan or set goals, nor do they determine the actions to be taken, resulting in less effective strategies being employed. This is shown by student's answer.

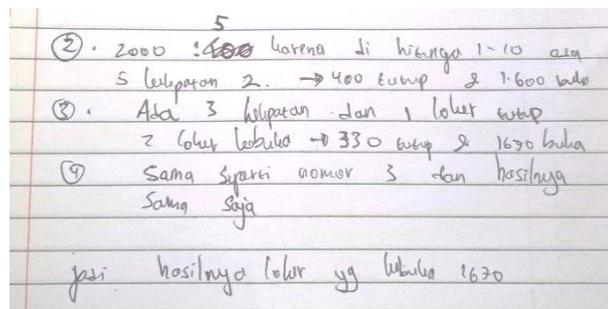


Figure 1. Student's answer for second problem

Based on Figure 1, this is can be seen in the answers given by student. The student tries to answer but does not check whether what the student gave is correct or not, then resulting in incorrect answer. Based on the responses of the ten students and comparing the scores given by each researcher, the final academic performance of each student is determined. The average scores for students with high magnitude are 60 for the first problem and 90 for the second problem. Meanwhile, students with low and medium magnitudes have average scores of 72.5 for the first problem and 71.25 for the second problem. Students with high strength obtained an average score of 72.5 for the first question and 80 for the second question, while students with low and medium strength scored an average of 68.33 for the first question and 71.66 for the second question.

Students with high generality achieved an average score of 60 for the first question and 90 for the second question, while students with low and medium generality scored 72.5 on the first question and 71.25 on the second question.

This is the result of students' metacognitive and academic performance from each dimension of self-efficacy

Tabel 3. Analysis Result of Students' Metacognitive and Academic Performance

Dimension	Category	Metacognitive						Average Academic Performance	
		Awareness		Evaluation		Regulation		1 st	2 nd
		1 st	2 nd	1 st	2 nd	1 st	2 nd		
		problem							
Magnitude	High	High	High	Medium	High	Medium	Medium	60	90
	Low-Medium	Low	Low	Medium	Medium	Low	Low	72.5	71.25
Strength	High	High	High	High	Medium	High	High	72.5	80
	Low-Medium	Low	Medium	Medium	Medium	Low	Medium	68.3	71.7
Generality	High	High	High	Medium	High	Medium	Medium	60	90
	Low-Medium	Low	Low	Medium	Medium	Low	Low	72.5	71.25

Based on that results in Table 3, researchers can analyze several things as follows. Firstly, the dimension of strength has a better average metacognitive than magnitude and generality. Students with high strength show high metacognitive in almost all activities, except for evaluation in the second question. Secondly, students with high self-efficacy dimensions tend to have higher metacognitive than students with lower self-efficacy dimensions. Thirdly, students with high strength have the highest average score for the first question compared to others, while students with high magnitude and high generality have the highest average score for the second question compared to others. These results are consistent with the research by Wibowo et al., (2018). Fourthly, in the first question, only students with high strength have a higher average score compared to students with lower strength. Whereas students with high magnitude and generality, have a lower average score than students with lower magnitude and generality in the first question. For the second question, students with high self-efficacy dimensions have a higher average score compared to students with lower self-efficacy dimensions.

Furthermore, researchers found some findings that can be further discussed. First, there is one student with low magnitude, low strength, and medium generality who scored 100 on both the first and second questions. Moreover, that student also tends to show high metacognitive in both questions. Second, students with high magnitude and high generality score low on the first question, even though students' awareness tends to be high in that question. Further analysis is needed to determine whether the students experience metacognitive failure (Rozak et al., 2020) or self-assessment errors, such as overestimation or underestimation (Sheldrake et al., 2022).

CONCLUSION

There are two important contributions to this research:

1. students with high self-efficacy dimensions tend to have higher metacognitive activity compared to students with the same dimensions but lower self-efficacy; second, students with high self-efficacy dimensions tend to have higher academic performance compared to students with the same dimensions but lower self-efficacy.
2. The high strength dimension plays a larger role in increasing metacognitive activity compared to other dimensions, namely magnitude and generality in the high category.

High generality and magnitude play a larger role in improving academic performance compared to other dimensions, namely high strength.

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