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UNRAVELING MATHEMATICAL REASONING: HOW SELF-EFFICACY INFLUENCES CONTEXTUAL PROBLEM-SOLVING IN LINEAR EQUATIONS OF ONE VARIABLE

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ABSTRACT
Mathematical reasoning ability is a logical thinking process that enables students to draw conclusions based on relevant facts, concepts, and information. Mathematical reasoning ability is very important in understanding mathematical problems, exploring ideas, estimating solutions, and expressing mathematical statements in appropriate mathematical terms, as well as understanding that mathematics is meaningful. There are four important indicators of mathematical reasoning ability, namely presenting mathematical statements in writing, making conjectures and performing mathematical manipulations, constructing proofs and solution processes, and drawing conclusions, providing reasons or evidence for the correctness of solutions. This study aims to describe the mathematical reasoning abilities of seventh- grade students in solving contextual problems on single variable linear equations based on self-efficacy. The study uses a qualitative descriptive approach. The research instrument is a test developed by the researcher and has been validated. The research was conducted at SMP Negeri 1 Baturetno, Wonogiri Regency, with 31 research subjects consisting of 7 students with high self-efficacy, 19 with moderate self-efficacy, and 5 with low self-efficacy. This article presents data from 3 subjects representing each level of self-efficacy. Data were collected through self-efficacy questionnaires and interviews, then analysed through data reduction, data presentation, and conclusion drawing stages. The results showed that students with high self-efficacy displayed all indicators of mathematical reasoning ability in solving problems, students with moderate self-efficacy performed two indicators of mathematical reasoning ability, and students with low self-efficacy only presented mathematical statements in writing.

INTRODUCTION

Mathematics education plays an important role in preparing quality learners for a role in the economy. Mathematics has an important role in creating workers who are able to compete globally. One of these roles is to

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nurture and develop logical, systematic, and analytical thinking skills, which are the main basis for solving problems in various aspects of life. Mathematics can help students build their knowledge and support their academic development. This is as stated by Aprisal (2018), who said that mathematics not only functions as a tool for calculation, but also as a universal language that enables humans to understand the patterns of the universe and create technology in an effort to support the advancement of human civilisation. In addition, mathematics is also the result of human thinking related to ideas, processes and reasoning (Minggi, Arwadi, & Bakri, 2022).

Mathematics can be mastered well if students have cognitive abilities such as mathematical reasoning to think logically and systematically. Reasoning is an important factor and one of the focuses that must be developed in the learning process Yumiati & Noviyanti (2017) also stated that "Mathematics assists students in dealing with challenges of an increasingly developing world, and as one of the media used is reasoning". Reasoning is a process of thinking in which students connect known facts to arrive at a conclusion that can be justified (Ario, 2016). Mathematical reasoning is a basic skill that plays a very important role in mathematics learning in schools, especially in junior high schools. This is in line with the research conducted by Zou et al. (2016) that the most important component emphasised in educational standards and the cognitive domain in the 21st century is reasoning skills.

Mathematical reasoning ability is a logical thinking process that enables students to draw conclusions based on relevant facts, concepts, and information (Hendriana et al., 2017). In mathematics learning, reasoning ability is used to solve everyday problems (Anita et al., 2022). This is also relevant to the results of research conducted by Mikrayanti (2016), which states that students experience difficulties in solving problems due to a lack of reasoning skills. Students need to know what factors can improve their mathematical reasoning skills. In line with this, the PISA 2022 framework also states that mathematical reasoning is formed by several key understandings that underlie mathematics in school, including: 1) understanding quantities, number systems, and their algebraic properties, 2) appreciating the power of abstraction and symbolic representation, 3) seeing mathematical structures and their regularities, 4) recognising relationships between quantities, 5) using mathematical modelling as a lens to the real world, and 6) understanding variation as the core of statistics (OECD, 2022). However, in reality, mathematical reasoning in Indonesia is still low and declining. This is evidenced by the results of the 2022 Programme for International Student Assessment (PISA) study, which shows that Indonesian students scored below the global average (OECD) in mathematics and experienced a decline compared to their 2018 scores. Based on the PISA results, Indonesia scored 366, below the OECD average of 472, a gap of 106 points from the OECD average score. In addition, Indonesia's average score also declined by 13 points from the previous year's score of 379 points.

The low mathematical reasoning ability of these students is also influenced by their affective abilities in mathematical thinking and behaviour . This is evident in the fact that many students give up easily when faced with mathematical problems because they consider them difficult and feel unable to solve them. One of the abilities that supports students' success in solving problems and has a major influence on students' mathematical reasoning abilities in achieving learning objectives is self-efficacy. According to Bandura in Fitriani (2017), self-efficacy is an individual's belief in their ability to perform tasks or actions to achieve certain results. Self-efficacy plays a very important role in the learning process. Students' belief in their ability to obtain the desired results from decision-making is the basic theory of self-efficacy, which is formed from students' behaviour when they decide to commit and persevere in their efforts to face obstacles and challenges (Bandura, 1997). The existence of self-efficacy or self-confidence motivates students to innovate or change and respond to each of these changes.

According to Bandura (1997), self-efficacy in each individual will differ based on three dimensions, namely level/magnitude (task difficulty level), strength (level of strength), and generality (generalisation). Each dimension is then used to create indicators to determine the level of self-efficacy possessed by each student. The level of self-efficacy can be categorised into three categories, namely high, medium, and low self-efficacy, which can be determined through a self-efficacy questionnaire given to students. Currently, there is still very limited research that systematically integrates self-efficacy and mathematical reasoning skills, particularly in solving contextual problems, into an integrated analytical framework. Most previous studies only discussed one variable or both without considering the contextual form of the questions. This shortcoming is increasingly apparent in the context of secondary education in Indonesia, as shown by the PISA results. This shows that students in Indonesia have difficulty understanding

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mathematical concepts, so they are less than optimal in applying them to solve everyday problems (Achmad & Nurwahidah, 2025). However, a comprehensive understanding of variations in students' self-efficacy towards mathematical reasoning abilities in solving contextual problems can make a meaningful contribution to the development of educational strategies in Indonesia.

The level/magnitude dimension (task difficulty level) in self-efficacy is the ability of students to solve problems based on the perception of task difficulty. Each student has different perspectives in facing mathematical tasks or problems. The more difficult the task, the weaker the confidence to be able to complete it. The *strength* dimension relates to the perseverance and resilience of students in carrying out their tasks. Students who have strong confidence in their abilities will persevere despite the many challenges and difficulties they face. In mathematics learning, strong confidence will motivate students to try to solve problems and remain consistent until their goals are achieved. Meanwhile, the generality dimension relates to students' ability to perform tasks in different situations through behavioural, cognitive, and affective means. This relates to students' experiences in completing a task or mathematical problem and increasing their confidence in their ability to complete similar tasks or face challenges that are more complex than before. These three dimensions have indicators that will be used as measuring tools.

Based on the above background, this study aims to describe the mathematical reasoning abilities of seventh-grade students in solving contextual problems on single variable linear equations in terms of high, medium, and low self-efficacy. The indicators of mathematical reasoning ability used in this study are presenting mathematical statements in writing, making assumptions and performing mathematical manipulations, compiling evidence and solution processes, drawing conclusions, and providing reasons or evidence for the correctness of the solution. This study needs to be conducted to examine the self-efficacy of students with mathematical reasoning abilities and to identify their weaknesses and strengths so that they can focus on acquiring knowledge that is not yet optimal. The uniqueness of this study lies in its integrative approach, which combines cognitive and affective aspects that have not been discussed in depth in the literature, especially at the junior high school level in Indonesia. This study is expected to provide new insights into the relationship between self-efficacy and mathematical reasoning abilities in solving contextual problems, thereby serving as a basis for developing educational policies for students with diverse characteristics. By developing mathematical reasoning abilities, students will not only be better prepared to tackle mathematical problems but will also acquire the skills needed to solve contextual problems. In this context, self-efficacy as a belief in oneself has a significant influence on students' mathematical reasoning abilities in solving contextual problems. High self-efficacy is associated with better reasoning, including using mathematical reasoning skills to understand mathematics and more effective time management, persevering more diligently, and persisting longer to complete tasks, especially when facing obstacles and difficulties (Bandura & Schunk, 1981; Rohana, 2015). Thus, although this study did not develop a new theory, the empirical findings contributed to the understanding of self-efficacy and mathematical reasoning abilities in solving contextual problems among junior high school students in Indonesia.

This study describes how mathematical reasoning abilities are viewed from the perspective of student self-efficacy. This study needs to be conducted because it aims to examine the self-confidence of students with mathematical reasoning abilities, as well as to explore the factors that influence students in solving contextual problems so that the knowledge gained is still not optimal. Therefore, the findings of this study can provide meaningful conceptual and applicative contributions in shaping educational policies that are more adaptive to the diversity of student characteristics and educational challenges in 21st century Indonesia. This research can be used as a reference in designing learning methods that are more suited to student characteristics. The qualitative descriptive approach used in this study is expected to contribute to understanding the factors that influence mathematical reasoning abilities in solving contextual problems from the perspective of self-efficacy and to open up space for further in-depth research.

METHOD

This study used a qualitative descriptive approach. This is a type of research in which the researcher and subjects interact directly in natural situations, and the researcher does not restrict the subjects so as to influence their nature. The data used is mathematical reasoning ability based on self-efficacy. The subjects in this study were 31

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students in class VIIB of SMP Negeri 1 Baturetno in Wonogiri Regency. The research subjects were students who had studied single variable linear equations, were skilled at demonstrating their self-efficacy when solving contextual problems, and had mathematical reasoning abilities.

The instruments used in this study were tests, questionnaires, and interviews. The tests used were contextual questions on single variable linear equations developed by the researcher. The interview guidelines contained focused questions to explore the subjects' self-efficacy in solving problems and to ascertain whether the subjects met the indicators of mathematical reasoning ability. In this study, the validators who validated the mathematical reasoning ability test instruments and interview guidelines consisted of three experts, namely mathematicians and educators. Meanwhile, the validators of the self-efficacy questionnaire instruments consisted of two experts, namely psychologists and educators. The validators provided corrections and suggestions to improve the quality of the instruments in terms of spelling and punctuation, as well as improving the language structure to make it easier to understand in the mathematical reasoning ability test, self-efficacy questionnaire, and interview guidelines. The mathematical reasoning ability questions are presented in Figure 1.

Single Variable Linear Equation Test Instrument
A group of students from SMP Negeri 1 Baturetno, Wonogiri Regency, visited Nampu Beach. They purchased souvenirs in the form of Wonogiri-style cassava chips before returning home. If they bought 8 packets of cassava chips and still had Rp 22,000 remaining from the Rp 150,000 they brought, then create a mathematical model to determine the price per packet of cassava chips.

Figure 1. Test Instrument

In this study, students were also given a self-efficacy questionnaire consisting of 25 statements with a 4 point Likert scale, namely Very Appropriate (VA), Appropriate (A), Not Appropriate (NA), and Very Not Appropriate (VNA), which were adjusted to the dimensions of self-efficacy. There were 24 statements in the self-efficacy questionnaire, consisting of 8 statements on the level/magnitude dimension (task difficulty level), 8 statements on the strength dimension (strength level), and 8 statements on the generality dimension (generalisation). Furthermore, the results of the questionnaire were then categorised based on the level of self-efficacy according to the score range obtained. Students' self-efficacy was divided into three levels, namely students with high, medium, and low self-efficacy. The author categorised the high, medium, and low levels by adding up the scores of each respondent's answers. The categorisation of self-efficacy levels is presented in Table 1.

Table 1. Categorisation of Self-Efficacy Levels

No	Level	Score	Respondents	Percentage
1	High self-efficacy	≥ 81	7	22.58
2	Moderate self-efficacy	62 - 80	19	61.29
3	Low self-efficacy	≤ 61	5	16.13

Based on the grouping results in Table 1, it shows that of the 31 respondents, who in this case were students, the majority were in the moderate category with 19 respondents (61.29%), followed by the high category with 7

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respondents (22.58%), and the low category with 5 respondents (16.13%). This indicates that the students' self-efficacy levels are generally in the moderate category, with some students showing relatively high self-efficacy and a small number in the low category compared to the group average. Next, students in the high, moderate, and low categories were selected using purposive sampling. In this article, one student from each self-efficacy level was selected for indepth analysis of their mathematical reasoning abilities.

The stages of data analysis in this study consisted of data reduction, data presentation, and conclusion drawing. Data reduction was carried out with the aim of determining the focus and core of what was needed in the study. Next, the data is presented to categorise mathematical reasoning abilities according to students' self-efficacy levels, namely high, medium, and low. The data is then described based on three dimensions of self-efficacy, namely level/magnitude (task difficulty level), strength (level of strength), and generality (generalisation). The final stage is the data conclusion drawing stage to answer the research questions.

RESULTS AND DISCUSSION

In this study, the author describes data from subjects at each level of self-efficacy with mathematical reasoning abilities in solving contextual problems on single variable linear equations. The data presented for each subject describes all data at each level of self-efficacy. Subject 1 (S1) is a subject with high self-efficacy, subject 2 (S2) with moderate self-efficacy, and subject 3 (S3) with low self-efficacy. The data analysis for each subject in this study involved presenting mathematical statements through writing, pictures, sketches or diagrams, making assumptions, performing calculations based on certain rules or formulas, checking the validity of an argument, and checking the validity of an argument.

Subject 1 (S1) with high self-efficacy

In the indicator of presenting mathematical statements in writing, S1 can mention and describe what is known from the contextual questions that have been read, as shown in Figure 1. In the indicator of proposing conjectures and performing mathematical manipulations, S1 can model in mathematical form and develop strategies for solving problems. In the indicator of compiling evidence and solution processes, S1 can compile solution steps based on certain methods or formulas and analyse the situation at hand. Then, in the indicator of drawing conclusions, providing reasons or evidence for the correctness of the solution, S1 has not yet made a final conclusion from the calculation results.

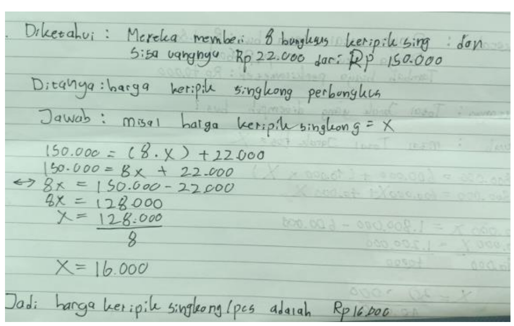

Figure 2. Subject 1 (S1) with high self-efficacy

Figure 2 shows that S1 is able to write down complete information about the question and is able to solve contextual questions well and correctly. In terms of level/magnitude (task difficulty), the interview results show that when working on the question, S1 is able to write down the information known from the question and feels optimistic about his ability to develop an appropriate strategy for solving the question. In the process of working on the problems, S1 also made assumptions to model them into mathematical forms first. In terms of strength, S1 had the resilience to not give up easily during the problem-solving process. This was proven by S1's persistence in applying the steps to solve the problems and the correct calculation results as seen in Figure 2.

In terms of generality, S1 feels confident that he can take responsibility for solving contextual problems and can master or control the situation by working within the time provided. This is shown in Figure 2, which illustrates

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that, conceptually, S1 can construct evidence and solution processes using solution steps based on specific methods or formulas. The final answer obtained by S1 is correct, and the conclusion-drawing stage is also carried out as shown in Figure 2.

Subject 2 (S2) with moderate self-efficacy

In the indicator presenting mathematical statements in writing, S2 can state and describe what is known and what is asked in contextual questions, as shown in Figure 3. In the indicator proposing conjectures and performing mathematical manipulations, S2 does not model in mathematical form but can develop strategies for solving problems. In the indicator of compiling evidence and solution processes, S2 can compile solution steps but not based on specific methods or formulas and analyse the situation at hand. S2 uses what is known in the question. Then, in the indicator of drawing conclusions, providing reasons or evidence for the correctness of the solution, S2 does not make a final conclusion from the calculation results.

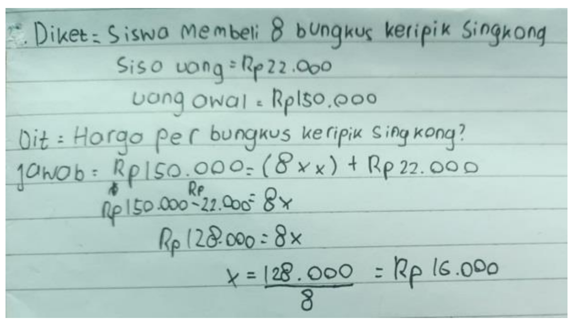
Diket: Siswa membeli 8 bungkus keripik singkong
Siso uang = Rp22.000
uang awal = Rp150.000
Dit: Harga per bungkus keripik singkong?
Jawab: Rp150.000 = (8 × x) + Rp 22.000
Rp150.000 − Rp22.000 = 8x
Rp 128.000 = 8x
x = 128.000 / 8 = Rp 16.000

Figure 3. Subject 2 (S2) with moderate self-efficacy

Figure 3 shows that S2 is able to write down the information in the question completely. In terms of level/magnitude (task difficulty), the interview results show that when working on the question, S2 is able to write down the information known from the question. However, S2 feels uncertain, so they read the question repeatedly until they feel confident and optimistic about their ability to develop a suitable strategy for solving the question. During the task, S2 admitted that they did not make any assumptions to model the problem mathematically first. This was because the way to solve the contextual problem was to use only the information provided. In terms of strength, although S2 felt doubtful at first, they had the resilience not to give up easily during the problem-solving process, as shown in Figure 3.

Furthermore, in terms of generality, S2 felt confident that he could take responsibility for solving contextual problems and could master or control the situation by working according to the solution steps he had learned. In terms of the solution stages, S2 felt that he was able to compile evidence and the solution process using solution steps based on the information in the problem. The final answer obtained by S2 is correct, but no conclusion was drawn in the last step. During the interview, S2 said that they were not accustomed to writing conclusions from the results obtained, so that obtaining the final answer was sufficient for them in answering the question, as shown in Figure 3.

Subject 3 (S3) with low self-efficacy

S3 on the indicator presents mathematical statements through writing, pictures, sketches or diagrams, writing down what is known from contextual questions as shown in Figure 2. S3 is incomplete in writing down what is known, but on the other hand, S3 can write down the information asked in the question correctly. Furthermore, on the indicator of proposing conjectures and performing mathematical manipulations, S3 can propose conjectures but does not model them in mathematical form, so they cannot develop a strategy for solving the problem. On the indicator of constructing evidence and solution processes, S3 cannot construct solution steps based on specific methods or formulas and analyse the situation at hand. Furthermore, on the indicator of drawing conclusions, providing reasons or evidence for the correctness of the solution, S3 does not make a final conclusion.

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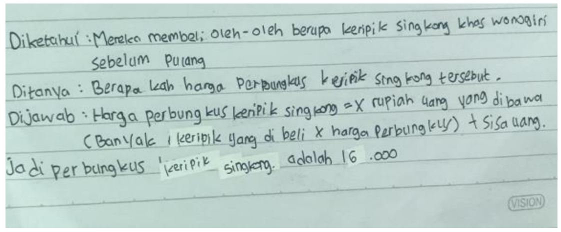

Figure 4. Subject 3 (S3) with low self-efficacy

Figure 4 shows that S3 wrote down what he knew from the contextual question he read, but did not represent information that could be used to solve the problem. In terms of level/magnitude (task difficulty), the interview results showed that S3 was confused about what to write down. S3 wrote down information based solely on his understanding of the contextual question. S3 wrote down what was asked correctly because they understood that the question word "how many" was the key. While working on the problem, S3 felt difficulty due to the limited information written in the question. S3 also did not make any guesses to model in mathematical form because they did not understand what to write when modelling. In terms of strength, S3 felt uncertain and a little discouraged about their ability to develop the right strategy to solve the problem. S3 also admitted that they could make assumptions, but they still felt unconfident about modelling in mathematical form and wrote according to their own wishes rather than not writing any answer at all. This feeling of giving up easily was due to limited knowledge and a lack of seriousness when working on the practice questions given previously. Despite feeling confused, unconfident and almost desperate, S3 had the resilience not to give up easily during the problem-solving process by continuing to write down answers as shown in Figure 4.

Meanwhile, in terms of generality, the interview results showed that S3 was able to solve contextual problems and control the situation by attempting to solve problems based on his knowledge. S3 also said that he had forgotten the material and practice questions he had studied, so he was unable to compile evidence and solution processes based on the steps required to solve the problems. The final answer obtained by S3 was correct, but it did not go through the solution process, so they jumped straight to the conclusion. Based on the interview results, S3 said that they did not have sufficient knowledge because when learning in class, they felt unfocused and afraid to ask the teacher if there was material that they did not understand. This made S3 try hard to continue solving contextual problems, which caused them to run out of time when working on the problems.

In terms of level/magnitude (task difficulty), subjects who were able to meet the indicator of presenting mathematical statements through writing, pictures, sketches or diagrams were those with high self-efficacy and were able to write down the information they knew and were asked in a complete and correct manner. Meanwhile, subjects with low self-efficacy needed to read repeatedly to ensure that the information written down could be used to solve contextual questions. Meanwhile, on the indicator of proposing assumptions to model mathematical forms, only subjects with high self-efficacy wrote down the desired mathematical models. This is because subjects with moderate self-efficacy forgot the steps in solving the problems so that they could use the available problem information. Meanwhile, subjects with low self-efficacy reasoned that they felt confused about what to do because they did not understand the material well.

In terms of strength (level of strength) with indicators of resilience and not giving up easily during the problem-solving process, subjects with high self-efficacy are confident and do not give up on solving problems. Meanwhile, subjects with moderate self-efficacy can solve problems even though they may have doubts during the process, as do those with low self-efficacy who feel like giving up because they cannot devise strategies to solve the contextual problems they face.

In terms of generality, subjects with high and moderate self-efficacy can take responsibility for solving contextual problems and can master or control the situation according to the steps for solving the problem and work within the time provided. Meanwhile, subjects with low self-efficacy work according to their existing knowledge without using the steps for solving the problem. Subjects with high self-efficacy draw conclusions after obtaining calculation results, but subjects with moderate and low self-efficacy do not draw conclusions and provide reasons or

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evidence for the correctness of the solution. This means that both subjects are unable to correctly draw final conclusions from the calculation results.

Subjects with high and moderate self-efficacy believe that they are optimistic about their ability to overcome difficulties, enabling them to present mathematical statements in writing, i.e., correctly stating and explaining what they know in the question. Meanwhile, subjects with low self-efficacy cannot state and explain what they know in the question because they do not believe in their ability ( ). Therefore, subjects with low self-efficacy do not meet the indicator of presenting mathematical statements in writing.

In terms of making conjectures and performing mathematical manipulations, subjects with high self-efficacy did not give up easily, enabling them to model problems mathematically and develop comprehensive problem-solving strategies. Subjects have the confidence that they can take responsibility for solving problems and can master or control situations. Meanwhile, subjects with moderate and low self-efficacy do not model in mathematical form and develop complete problem-solving strategies. Therefore, the indicators of making conjectures and performing mathematical manipulations are not met.

In terms of compiling evidence and solution processes, subjects with high and moderate self-efficacy can compile complete steps for resolution based on specific methods or formulas. Subjects have the confidence that they can take responsibility for solving problems and can analyse the situations they face. Meanwhile, subjects with low self- efficacy do not compile solution steps based on specific methods or formulas because they are unsure of their abilities and easily give up when encountering difficulties in mathematical problems. Therefore, the indicator of compiling evidence and solution processes is not fulfilled.

In the indicator of drawing conclusions, providing reasons or evidence for the correctness of the solution, subjects with high self-efficacy made final conclusions from the calculation results, while subjects with moderate or low self-efficacy did not make final conclusions from the calculation results. Subjects with moderate self-efficacy believe that when solving problems and obtaining final results, it is not necessary to write conclusions about the results obtained. Meanwhile, subjects with low self-efficacy make final conclusions without going through the process of solving the problem. Therefore, in the indicator of drawing conclusions, providing reasons or evidence for the correctness of the solution is not fulfilled.

CONCLUSION

Subjects with high self-efficacy in solving contextual problems are tend to be more able to perform all stages of mathematical reasoning ability indicators well. In the dimensions of level/magnitude (task difficulty), strength (level of strength), and generality dimensions, these subjects involved indicators of mathematical reasoning ability, which included presenting mathematical statements in writing, making assumptions and performing mathematical manipulations, compiling evidence and solution processes, drawing conclusions and providing reasons or evidence for the correctness of the solution in each stage of solving contextual problems.

Subjects with self-efficacy in solving contextual problems can use all dimensions of self-efficacy: level/magnitude (task difficulty level), strength (level of strength), and generality (generalisation). However, this is only used to solve contextual problems in indicators of presenting mathematical statements in writing, performing mathematical manipulations, and compiling evidence and solution processes. The subjects did not perform the indicator stages of proposing hypotheses, drawing conclusions, and providing reasons or evidence for the correctness of the solution. Thus, the mathematical reasoning ability stages in this indicator were not fulfilled because the subjects directly calculated and obtained the results.

Subjects with low self-efficacy in solving contextual problems display some aptitude in all dimensions of self-efficacy: level/magnitude (task difficulty level), strength (level of strength), and generality (generalisation). However, this is only used to solve contextual problems on indicators that present mathematical statements in writing. At this stage, subjects do not write down what they know with complete information related to answering the question even though what is asked is correct. Essentially, what happens is that subjects have difficulty processing the information in the question and do not understand what the question means. This results in subjects being unable to solve the problem with the stages appropriate to the mathematical reasoning ability indicator. Thus,

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the subject does not perform the indicators of making assumptions and performing mathematical manipulations , compiling evidence and solution processes, drawing conclusions and providing reasons or evidence for the correctness of the solution. Therefore, the indicators of mathematical reasoning ability are not fully met.

This study was used to train students' mathematical reasoning skills in solving contextual problems so that students gain confidence in understanding mathematics and managing time more effectively, strive more diligently, and persevere longer to complete tasks, especially when facing obstacles and difficulties. Solving contextual problems with mathematical reasoning skills through four problem-solving indicators can enable students to assess their level of confidence regarding their ability to complete a task to achieve the expected results. One of the shortcomings or difficulties students face is identifying contextual problems, so teachers should ask students to get used to writing down their problem-solving steps systematically, starting from identifying the information in the problem to drawing conclusions and providing reasons or evidence for the correctness of the solution.

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