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MEASUREMENT OF MATHEMATICAL PROBLEM SOLVING ABILITY BASED ON SELF EFFICACY CATEGORIZATION USING MIXED METHODS APPROACH

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Abstract

Mastering problem solving is the goal of mathematics learning. Students' ability to solve math problems is still relatively low. Self-efficacy is one of the factors related to student competence. The purpose of this study was to assess proficiency in solving math problems using the Polia level, which is based on students' levels of self-efficacy. The study was conducted in class XI SMAN 1 Konawa Utara with a total of 37 students. This type of research is descriptive, quantitative, and qualitative in the form of mixed methods. The research instruments consisted of a test of mathematical problem-solving ability, a self-efficacy questionnaire, and an interview guide. Data were analyzed using descriptive-quantitative and descriptive-qualitative techniques, or mixed techniques. Studies have shown that students with high self-efficacy are able to solve math problems after going through all stages of Polya. Students with moderate or low self-efficacy, on the other hand, go through all stages of polya and are unable to solve problems. It was concluded that a student's level of self-efficacy influenced their ability to solve math problems based on stages of Polya.

Keywords: Mathematical problem-solving ability; self-efficacy.

Abstrak

Penguasaan terhadap pemecahan masalah menjadi tujuan pembelajaran matematika. Penguasaan peserta didik masih rendah terhadap pemecahan masalah matematika. Efikasi diri adalah salah satu faktor yang memiliki keterkaitan dengan kompetensi peserta didik. Penelitian ini bertujuan menganalisis kemampuan pemecahan masalah matematika berdasarkan tahapan Polia ditinjau dari level efikasi diri. Penelitian ini dilakukan di kelas XI SMAN 1 Konawa Utara dengan jumlah subyek 37 orang. Penelitian ini menggunakan metode campuran dalam bentuk deskriptif kuantitatif dan kualitatif. Instrumen penelitian terdiri dari tes kemampuan pemecahan masalah matematika, kuesioner self-efficacy, serta pedoman wawancara. Data dianalisis menggunakan teknik deskriptif kuantitatif, deskriptif kualitatif dan triangluasi. Hasil penelitian telah menunjukkan bahwa peserta didik dengan level efikasi diri tinggi mampu memecahkan masalah matematika menggunakan semua tahapan Polya dengan baik, sementara peserta didik dengan level efikasi diri sedang dan rendah belum mampu menyelesaikan masalah matematika menggunakan semua tahapan Polia. Disimpulkan bahwa level efikasi diri mempengaruhi kemampuan dalam menyelesaikan masalah matematika berdasarkan langkah-langkah Polia.

***Kata kunci**: Kemampuan pemecahan masalah matematika; self efficacy*

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INTRODUCTION

Mathematical problem-solving ability is a very important part of learning mathematics because it is the basis for developing competency and mastery of the concept and application of mathematics. To develop problem-solving abilities in mathematics need to have the skills to understand the problem, make a problem-solving plan, solve the problem according to the plan, and reflect or re-examine the solutions found. Mathematical problem-solving can be mastered if it is supported by good affective abilities, one of which is self-efficacy

The development of learning quality is very closely related to the learning process that takes place in schools (Zagoto & Dakhi, 2018), including learning mathematics (Kelley & Knowles, 2016). Conceptually, learning mathematics can be effective if learning emphasizes understanding structures and concepts, and pays attention to the close relationship between these structures and concepts. (Collins & Kapur, 2014). It is hoped that the structures and concepts discussed can be understood and mastered by students. Students will more easily understand and remember the material discussed if it has a certain structure and pattern, and this is related to solving the problem in mathematics. (Asri & Noer, 2015; Gazali, 2016; Ningsih, 2014). Problem-solving ability is an action to solve problems using the strengths and benefits of mathematics solving problems, which is also a method of finding solutions through systematic stages (Cahyani & Setyawati, 2016).

Maximum mathematical problem-solving ability can be achieved by facilitating students through learning activities (Nurqolbiah et al., 2016). Meanwhile, the curriculum agreed to be used as a learning guide demands a student-centered learning process (Zuraidah et al., 2015), which can create challenging but fun conditions, develop the creativity of students, develop abilities that are varied and value-laden, provide experiences for learning, and learning by doing (Ahmad, 2017)

Through solving mathematical problems, learning outcomes that can be achieved are not only understanding the concepts, many things that arise in the learning process including the meaningfulness of learning contained in the problem-solving component (Saputra & Mujib, 2018). Therefore, in solving problems it is necessary to develop an understanding of the problem and determine a mathematical model for solving, solving problems, and finding solutions (Ardhiyah & Radia, 2020). Mathematical problem-solving is an integral part of the mathematics curriculum, which cannot be separated from mathematics education or learning (Eviyanti et al., 2017; Khotimah & Masduki, 2016); If a student has practiced solving problems then in real life he will be able to make decisions about a problem, therefore problem-solving skills are an important part of learning mathematics (Asis et al., 2017).

Based on the description that has been stated, one of the skills that is mandatory and important for training high school students is the ability for solving the problems. Several studies have revealed that mathematical problem solving is a basic mathematical ability that has to be instilled in high school students (Widodo et al., 2018). The ability for solving problem in mathematics is generally still in the low category and not optimal (Holidun et al., 2018). The ability for solving a problem has a correlation with personal factors such as self-confidence (Utami &

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Wutsqa, 2017), student interest (Jatisunda, 2017), self-efficacy (Amalia et al., 2018).

Students are often faced with problems of insecurity and not even confidence in the results obtained in solving math problems (Ramdan et al., 2018). Self-Efficacy in mathematics is students' belief in the ability for solving a problem in mathematics (Jatisunda, 2017). In another section stated that self-Efficacy will affect action, effort, and flexibility in differences (Darta, 2021). High and low Self-Efficacy combine with responsive and unresponsive environments (Nanda & Widodo, 2015). If students have high Self-Efficacy, they will be supported by a responsive environment so that the possibility of success in learning is greater, and vice versa (Widyaninggar, 2015).

Self-Efficacy affects how a person thinks, feels, motivates himself, and acts, affecting the success and failure of students in mathematics (Todor, 2014). Self-efficacy also affects students' ability to solve math literacy problems. Self-efficacy with high level is better than self-efficacy with low level (Busnawir, 2021).

The previous description shows that self-efficacy has an important role for the abilities of students in the process of learning, including mastery in solving mathematical problems, but has not explained in detail the differences in the abilities for solving the problem in mathematics based on polya steps in matrices, sequences, and series material. In this section, quantitative and qualitative studies are conducted to analyze the ability of students for solving problems in mathematics related to the level of self-efficacy. The quantitative study was intended to analyze differences in descriptions of the ability of students for solving the problem in mathematics based on a high, medium, and low levels of self-efficacy. Qualitative research is intended to analyze the mastery for solving the problems in mathematics regard to the Polya steps, namely to understand the problem, develop a problem solving plan, solve the problem and check again (Hasan, 2019; In'am, 2014).

The objective of this study was to analyze the differences of the ability of students to solve the problem in mathematics according to Polya stages based on different categories of students' self-efficacy levels. It is hoped for the results of the study will provide an overview of the ability of students to solve problems in mathematics who have high, medium, and low level of self-efficacy and their differences.

RESEARCH METHOD

This research method uses a mixed method, namely a quantitative approach supported by qualitative analysis to explain the characteristics of mathematical problem-solving abilities according to Polya's steps based on self-efficacy level categorization (Rivai & Yuliati, 2018). Quantitative methods are used to describe differences ability of students to solve the mathematical problem between self-efficacy levels, while qualitative methods are used to describe mastery of indicators of the abilities for solving mathematical problem regard to Polya's steps which include understanding the problem, developing a plan for solving the priblem, solve the problem and check again (Arwanto et al., 2018; Soebagyo et al., 2022).

This research was conducted at SMA Negeri 1 Wiwirano Konawe Utara, in class XI with a total of 39 students as subjects. When the research is carried out in the even semester of the

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2021/2022 school year. The research instruments consisted of tests for measuring of the ability to solve the problem in mathematics, questionnaires for measuring self-efficacy, and interview guidelines.

The stages of data collection are carried out as follows. In the early stages, students were given a self-efficacy questionnaire of 30 statements with 5 answer choices namely strongly agree (SS), agree (S), doubt (RR), disagree (TS), and strongly disagree (STS) consisting of positive and negative statements that have been validated with a reliability level of 0.86. The self-efficacy questionnaire was developed based on three indicators that are magnitude, strength, and generality (Ramdhani et al., 2017; Masitoh & Fitriyani, 2018). Students' self-efficacy scores are grouped into three categories, namely high, medium, and low based on the average value and standard deviation of the distribution of respondents' scores (Dewantara et al., 2021; Kartikarini & Purwanti, 2022; Ramdhani et al., 2017).

In the next stage, students are given tests of ability to solve mathematical problems on matrices, sequences, and series material taught in class XI in high school. The test given contains 3 questions in the form of a description test which contains indicators of include understanding the problem, developing a plan for solving the problem, solve the problem and check again according to Polya's steps. The scoring technique for mathematical problem-solving abilities uses a rubric with a minimum score of 0 and a maximum of 3 for each Polya step so that the maximum total score is 36 (Rosli et al., 2013; Widodo et al., 2021). The test used was validated by two experts (mathematics education lecturers). Based on the results of the validation, improvements were made so that it fulfilled the construct validity as suggested by the panelists.

In addition to using questionnaires and tests, data collection was strengthened by the results of interviews with three subjects who represented high, medium, and low self-efficacy, which aimed to explore deeply and verify the process of solving mathematical problems which have been done.

The data in this study were analyzed by using descriptive statistics to determine self efficacy tendencies and the ability of students to solve the problem in mathematics. Then the t-test was used to explain the differences ability of students in solving a problem in mathematics based on a high, medium, and low levels of self-efficacy. Qualitative analysis was carried out through three main stages, namely reduction of the data, making the display of the data, and making conclusions or verification of the data (Fadzillah & Wibowo, 2016). To test the validity of the data, triangulation of data sources was used, namely checking the correctness of the subject's answers, determining the part that needed to be confirmed, and conducting deep interviews related to the subject's answers.

FINDINGS AND DISCUSSION

The findings of this study are described based on the results of quantitative analysis and qualitative analysis. The results obtained based on quantitative analysis explain the characteristics of the ability of students to solve the problem in mathematics based on students' self-efficacy in the high level, medium level, and low level; then analyze the difference of the ability of students to solve the problem in

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mathematics between the level of self-efficacy. The results of the qualitative analysis explain the ability of students to solve the problems in mathematics based on Polya stages for each level of self-efficacy.

Based on the answers of 39 students sampled in this study to the self-efficacy questionnaire, the average score was 96.28, the minimum score was 78, the maximum score was 124, the standard deviation was 10.55, and the variance was 111.31. More detailed score characteristics are shown in Figure 1.

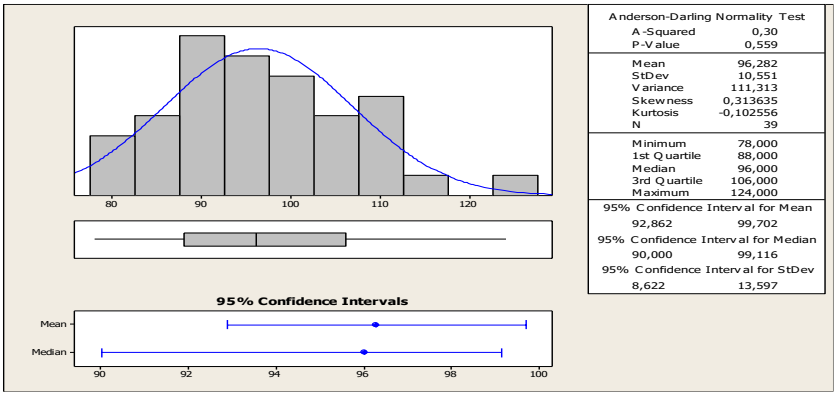

Figure 1. Graphical summary of self-efficacy score

The distribution of students' self-efficacy scores as visualized in Figure 1, shows a curve that tends to be normally distributed which is also shown by the "Anderon-Darling Normality Test = 0.30 with P-Value = 0.559". Based on Figure 1 it can also be explained that lower scores are more dominant to the left of the median, which means that students tend to have lower self-efficacy. That is, students tend to lack the confidence to be able to solve the math problems they face.

Table 1. Frequency Distribution of Self-Efficacy Scores

No	Self Efficacy Categories	Score Ranges (X)	Frequency (%)
1.	High	$X > 106.83$	8 (20,51)
2.	Medium	$85.73 \leq X \leq 106.83$	14 (35,90)
3.	Low	< 85.73	17 (43,59)
	Total Score		**39 (100)**

Table 1 describes the score ranges for determining high level, medium level, and low level of the self-efficacy categories based on the average value and standard deviation. It can be seen that the percentage of students who have low self-efficacy is greater than the percentage of students who have moderate or high self-efficacy. This gives an indication that most students still have self-efficacy in the low category.

The mathematical problem-solving abilities analyzed in this study consisted of 3 items, each item having a minimum score 0 and a maximum score 12 so that the total theoretical score is in the range of 0-36 with a median score of 18. Then a description of the ability of students to solve the problems in

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mathematics is made based on high level, medium level, and low level of self-efficacy, which are described in the following sections.

The characteristics of students' mathematical problem-solving ability scores that have self-efficacy in the high category are shown in Figure 2.

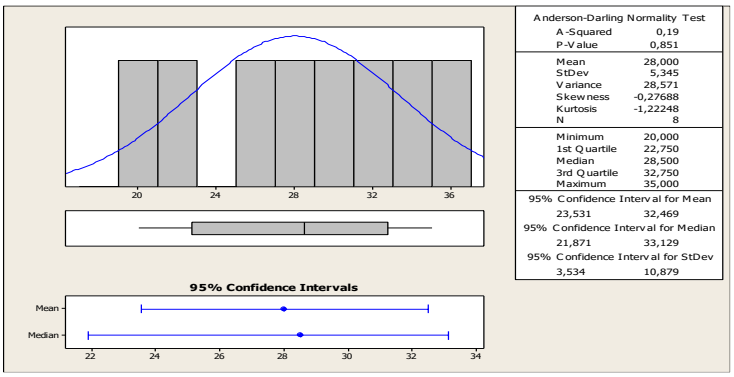

Figure 2. Characteristics of the Problem-Solving Ability Score

Figure 2 provides information that the score characteristics of the ability of students to solve the problems in mathematics with high level of self-efficacy are normally distributed in the score range of 20–35. The mean score and median score are greater than the theoretical average score (18.00), thus indicating students in this group have ability to solve the problem that tend to be high and relatively uniform.

The characteristics scores of the ability of students to solve the problems in mathematics that have self-efficacy in the moderate category are shown in Figure 3.

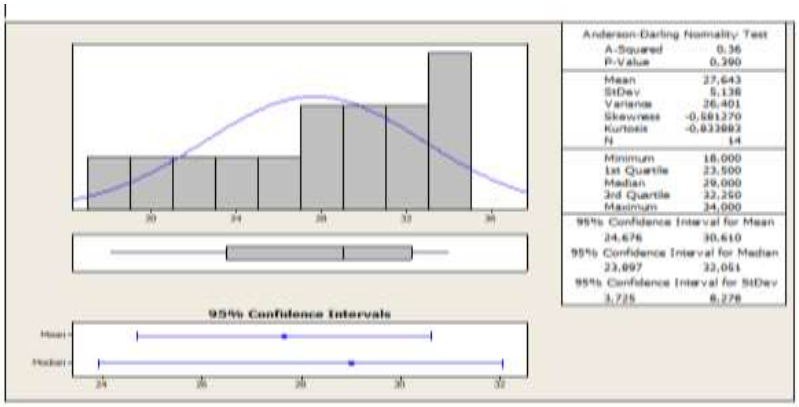

Figure 3. Characteristics of the problem-solving ability score mathematics for moderate self-efficacy

Figure 3 provides information that the score characteristics of students' mathematical problem-solving ability with moderate self-efficacy are normally distributed in the score range 18 – 34. The mean score and median score are greater than the theoretical average score (18.00) which indicates students in this group have high math problem-solving abilities as well as high self-efficacy, however, judging from the shape of the curve, individual scores in this group vary quite a bit.

Figure 4. describes the characteristics of students' math problem

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solving ability scores with low self- efficacy.

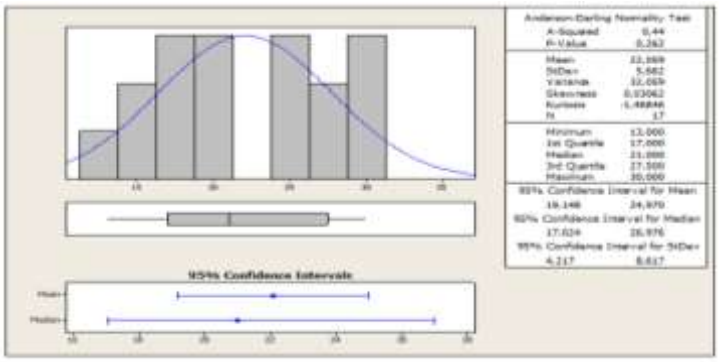

Figure 4. Characteristics of the problem-solving ability score mathematics for low self-efficacy

Based on Figure 4 it can be explained that the score characteristics of students' math problem solving abilities with self-efficacy are low and normally distributed in the score range 13–30. The mean score and median score are also greater than the theoretical average score (18.00). which provides information that in groups of students with low self-efficacy have mathematical problem-solving abilities tend to be high compared to the average theoretical scores and varying abilities.

The results of the different test scores on the average ability to solve the problem between students who have high level and moderate level self-efficacy produce a t-value = 0.15 and a P-value = 0.879 at degrees of freedom = 20. Therefore the P-value produced is over than the level significance of α = 0.05, it is stated that the test results are not significant. With respect to the results of this test, it indicates that there is no significant difference in the ability to solve mathematical problems between students with high self-efficacy and students with moderate self-efficacy, but quantitatively the high self-efficacy group has a higher average score of 0.457.

The results of the different test scores on the average ability of students to solve the problem in mathematics between students that have high-level self-efficacy and low-level self-efficacy produce a t-value = 2.49 and a P-value = 0.020 at degrees of freedom = 23. The results obtained are a smaller P-value than the significance level α = 0.05 so that it is declared significant which gives an indication of differences in mathematical problem-solving abilities between students with high self-efficacy and students with low self-efficacy.

The results of the different test scores mean of the ability of students to solve the problem in mathematics between students that have moderate level self-efficacy and low level self-efficacy produce a t-value = 2.85 and a P-value = 0.008 at degrees of freedom = 29. The results obtained are P-value on the test is smaller than the significance level α = 0.05 so it is declared significant, which means that there are differences of the ability to solve the problem between students that have moderate self-efficacy, and students who have low self-efficacy.

Graphically, the distribution of characteristics and the average score of mathematical problem-solving abilities

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between the three self-efficacy categories are expressed in the form of a boxplot as shown in Figure 5.

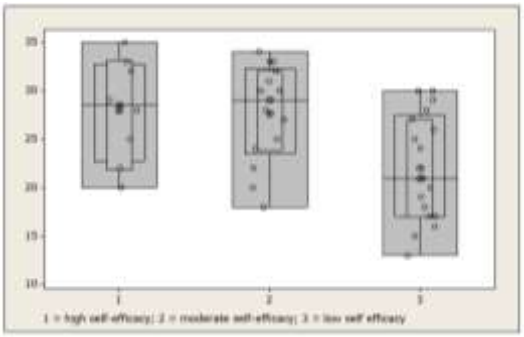

Figure 5. Boxplot of problem solving ability score mathematics based on self-efficacy category

In Figure 5, it can be seen that boxplot 1 and boxplot 2 seem to have relatively the same distribution of scores and mean values, in contrast to boxplot 3 which looks lower than the others. This confirms the test results as previously described.

Qualitative analysis in this study was carried out by tracing and examining students' answers to tests of abilities to solve the problem based on the Polya step which consisted of understanding the problem, developing a plan for solving the problem, solve the problem and check again. For the sake of analysis, 3 subjects (students) were selected, one each representing high level, medium level, and low level self-efficacy. Subjects selected in each category are subjects who get a problem-solving ability score in the median position. The selected subjects are shown in Table 2.

Table 2. Subjects for interviews

No	Subject Category	Subject Code
1.	High Self- efficacy	S13
2.	Moderate Self-icacy	S32
3.	Low Self-efficacy	S06

Based on Table 2, a subject code is given for each self-efficacy category, which is then traced related to the answers to the mathematics problem-solving ability test through interview activities. Tracking answers and interviews to subject S13. When solving question number 1, the subject can understand the problem well. When conducting interviews, the subject can explain what is known and what is being asked about the items. The tester did a good job planning the problem solution, it can be seen from the answers written and can explain the formulation that will be used to solve the problem. The subject can also be said to have been able to carry out problem-solving, as seen from the completion of the questions written, and can explain the steps to solve the problem. During the phase of reviewing the results of problem solving, subjects can only arrive at the arithmetic calculation stage, not until proof again.

When solving question item number 2, subject S13 has a better understanding of the problem by writing down all known elements and questions. During the interview, the examiner was able to explain what he knew and what was asked in the question. Subjects are good at planning problem-solving because they can write down the formula or equation needed and can explain the concept of the formula used to solve the problem. The subject is also able to do problem-solving because he is able to write down and explain the steps to solving the problem. At the stage of re-examination of problem-solving, the subject only arrived at arithmetic calculations and had not been able to prove them backward.

When solving question item number 3, Subject S13 was able to better understand the problem by

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writing down completely what he knew and what was asked in the task. Subjects were able to explain the concepts of the formulas used to solve the questions asked, so they were able to develop a problem-solving plan. . Subjects can be said to have been able to do problem-solving by writing the appropriate formula and explaining the problem-solving steps in the problem systematically. At the re-examination stage, the subject did quite well and made good use of the time allotted. As a whole, the subject's work is considered quite good

Tracking answers and interviews with subject S32. At the time of solving question number 1, the subject was able to understand the problem because he was able to write down and explain what was known and what was asked in the problem. In terms of planning problem solving, the subject was able to write on the answer sheet and explain during an interview the concept of the formula used to solve the problem in the item questions. The subject can also carry out a problem-solving plan which is indicated by solving the questions that have been done and can also explain the appropriate steps during the interview. Meanwhile, at the stage of re-examining problem solving, the subject reached the stage of looking back at the calculation process if something went wrong.

When solving question number 2, subject S32 understood the problem well but did not write it down completely. During the interview, the subject can explain what is known and asked, although they do not write it explicitly on the answer sheet. Subjects were also able to plan problem-solving by writing on the answer sheet and explaining during the interview the concept of the formula to be used. Subjects can carry out problem-solving which is shown through the things written on the answer sheet and explain the steps in solving the problem. On the other hand, at the stage of re-examining the results of solving the problem, it remained at the stage of confirming the calculation results.

By the time question number 3 was solved, subject S32 already understood the problem and was able to plan and execute the problem solving, but it was not perfect. This is clear from the work results and from the explanations given in the interviews, the solutions given were incomplete. At the re-checking stage, the subject did not do it because the allotted time was running out.

Tracking answers and interviews to subject S06. At the time of solving question number 1, the subject could not understand the problem well, even though he was able to write down what he knew about the problem and what was asked but could not explain it well during the interview. Subjects were able to plan problem-solving by writing on the answer sheet and explaining during the interview the concept of the formula used to solve the problem. The subject is also able to carry out the problem-solving stage by writing and explaining the procedural steps used. In the troubleshooting re-examination stage, the subject could not do it because they did not understand the part that needed to be re-examined.

At the time of solving question number 2, the subject was able to understand the problem well, but could not plan a solution to the problem because the concept of the formula to be used to solve the problem was not written down in full due to limited understanding. The subject also has not been able to carry out problem-solving

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properly because the steps to solve the problem written are incomplete and do not re-examine the problem solving that has been done.

When solving problem number 3, Subjects failed to adequately complete all stages to solve the problem, beginning with problem understanding, problem solving planning, problem solving execution, and review. at interview, some of these stages could be explained but could not be written down perfectly on the answer sheet. According to the subject, this was caused by not getting used to writing down explicitly what was known and what was in his understanding when solving question item number 3, Subject S13 was able to better understand the problem by writing down completely what he knew and what was asked in the task. Subjects were also able to plan problem-solving well because they were able to explain the concept of the formula used to solve the questions posed. Subjects can be said to have been able to do problem-solving by writing the appropriate formula and explaining the problem-solving steps in the problem systematically. At the re-examination stage, the subject did quite well and made good use of the time allotted. As a whole, the subject's work is considered quite good.

Quantitatively, The results of this study show that students' self-efficacy is directly proportional to their ability to solve math problems. In other words, students with high self-efficacy tend to be better at solving math problems, and students with lower self-efficacy tend to be less capable at solving math problems. This result is supported by previous research conducted by Somawati (2018); Yuliyani & Handayani (2017) who argued that the ability to solve mathematical problems is significantly influenced by self-efficacy, the higher the student's self-efficacy, the easier it is to solve mathematical problems. Marasabessy (2020) in his research, he found that students with high self-efficacy were better at solving math problems. When Self-Efficacy is high, problem-solving abilities will be high. Peranginangin et al., (2019) found that students who are in the higher self-efficacy category tend to have better problem-solving skills**.**

This study found that there were differences in the characteristics of students' mathematics problem-solving skills, which were reflected in differences in self-efficacy. Students with high self-efficacy can understand math problems better, make plans to solve problems appropriately, carry out systematic problem-solving, and carry out a re-examination of problem-solving that has been done. Students with low self-efficacy, on the other hand, did not fully understand the problem and there are still errors that are not quite right, have not been able to determine the right problem-solving plan such as determining the appropriate modeling, and have not re-examined the problem-solving. This is reinforced by the results of research conducted by Sutrisno & Kharisudin (2020) which stated that only students with a very high self-efficacy category could show very good performance at each step of problem-solving. Utami & Wutsqa (2017) explained that students with high levels of self-efficacy tended to have better problem-solving skills than those with low levels of self-efficacy. Students with low mathematics problem-solving ability were thought to be caused by previous learning experiences that were not very cooperative.

A student with a moderate sense of self-efficacy is basically able to solve

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problems related to solving math problems, but each step cannot be done perfectly or completely. Students can verbally describe the solution to a particular problem, but cannot write down the mathematical symbols associated with problem solving completely and systematically. Because, students are not used to using mathematical formulas and symbols to write down what comes to mind. Students have less practice expressing in written form what is known and plans for solving a mathematical problem. Such a phenomenon is related to the still low mathematical communication skills of students. . Qohar & Sumarmo (2013) suggest mathematics is a symbolic language that must be learned related to communication skills. Omidire et al., (2018) stated that mathematics is a language in a social activity so it is important to develop in learning activities.

For students with low self-efficacy, almost every step of problem-solving cannot be carried out completely and systematically, especially concerning problem-solving plans, implementing problem-solving, and looking back at the problem-solving process. At the stage of re-examining the problem-solving process, students in this category are of very low ability. Students with low self-efficacy have weaknesses in terms of strength of belief, and courage to face challenges and take risks for the decisions they make, are less able to interact with others and do not recognize their abilities and weaknesses. Put forward by (Alrajhi et al., 2017), that individual responses in processing beliefs, perceptions, and feelings in solving a problem depend on their self-efficacy. (Ramlan, 2016) stated that self-efficacy has an impact on the ability to think and take action to solve a problem. Sivrikaya (2019) in his research results, stated that self-efficacy is the belief of each individual that leads to the achievement of a goal.

CONCLUSIONS

The conclusions of this study are:

differences in students' self-efficacy influence differences in their math problem-solving abilities according to Polya's steps. Students with high self-efficacy can solve math problems based on Polya's steps. Students with moderate and low self-efficacy, on the other hand, are unable to solve math problems based on the Polya steps.

This study presents several suggestions. Especially during the review phase of the problem-solving process, students' learning experience should be enhanced through the practice of math problem-solving activities based on the Polya level. Improving self-efficacy is an area that needs attention. Other researchers can therefore investigate factors that may increase students' self-efficacy related to their ability to solve math problems.

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