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High school students' mathematical proficiency based on mathematics anxiety and cognitive independence

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Abstract

Mathematical proficiency is the ability to use conceptual understanding, procedural fluency, strategic competence, adaptive reasoning, and productive disposition in problem-solving. This study aims to determine the effect of mathematics anxiety level and cognitive independence level on mathematical proficiency. This research combined quantitative and qualitative methods to determine the effect of mathematics anxiety and cognitive independence on mathematical proficiency. It used the multiple linear regression test for the quantitative approach. Moreover, the qualitative approach was used to see the effect of anxiety level and cognitive independence on mathematical proficiency. One hundred fifty-five high school students participated in this study, and it was found that mathematics anxiety affects mathematical proficiency negatively while cognitive independence affects mathematical proficiency positively. Students who have high mathematics anxiety use trial and error strategies, while their counterparts, having low mathematics anxiety, use analytical strategies. Students with high cognitive independence can process the information and tend to be independent, while those with low cognitive independence do so illogically and tend to need help from others. The results of this study are hoped to be beneficial for teachers in choosing learning methods.

Keywords: analytical strategy; cognitive independence; mathematical proficiency; mathematics anxiety; trial-error strategy;

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1. Introduction

Students' ability to solve mathematical problems efficiently will be essential in solving everyday life problems. The ability to solve problems in mathematics can be developed because students know the usefulness of mathematics in everyday life. In addition, the ability mentioned is also related to students' thinking skills. Mathematical problem solving makes students use their thinking skills more actively to deal with new situations and focus on understanding mathematical ideas (Budayasa & Juniati, 2019; Firdaus et al., 2020). Therefore, it is essential to understand the factors that affect students' ability to solve mathematical problems.

The ability to solve mathematical problems is known as mathematical proficiency. Mathematical proficiency is factor within students that support their success in learning mathematics (Awofala, 2017). Mathematical proficiency is the ability of individuals to solve problems faced using understanding, computation, application, reasoning, and involvement (Groves, 2012). Mathematical proficiency consists of five strands interconnected with each other. Four strands are related to thinking skills, which are conceptual understanding, procedural fluency, strategic competence, and adaptive reasoning as well as one strand related to attitudes towards mathematics, namely productive dispositions (Kilpatrick, 2001). Conceptual understanding relates to the understanding of concepts, operations, and their relationships (Awofala, 2017). Procedural fluency is related to the skills possessed in implementing procedures flexibly, efficiently, and in accordance with the context (Khalil & Alnatheer, 2020). Strategic competence is the ability to use strategies to understand, represent, and solve the problem situations (Rahman et al., 2022). Adaptive reasoning is a mental activity connecting several concepts, facts, and procedures (Syukriani et al., 2017). Finally, productive disposition is related to a positive attitude and the ability to realize mathematical values (Jawad, 2021). Mathematical skills can help students solve problems in daily life.

The better students apply mathematical proficiency, the more problem-solving skills will increase (Awofala, 2017). Several researchers showed how to develop mathematical proficiency, such as using mathematical modelling tasks (Corrêa, 2021), using innovative matrix strategy, and the problem tree strategy (Jawad, 2021). However, it was still found that mathematical proficiency did not develop well. As in solving problems, only the ability of procedural fluency and productive disposition had a significant effect on other skills that had no impact (Awaji, 2021). Therefore, it is necessary to examine the description of factors that influence mathematical proficiency in solving mathematical problems.

Students aged 15-17 can be regarded as individuals who are prepared to face problems in their daily lives. Based on Piaget's theory that every child aged 13-17 years belongs to formal surgery, namely children who can start thinking logically and abstractly (Babakr et al., 2019). Such an age is individuals who study in high school. Mathematical proficiency is abstract thinking skills that can be developed in high school students.

Factors that influence students' mathematical proficiency are the level of anxiety of students in learning and completing mathematical tasks. Excessive mathematics anxiety would hinder students' ability to solve problems. Students who feel anxious about learning mathematics will have their ability to solve mathematical problems reduced (Juniati & Budayasa, 2021). Mathematics anxiety affects students' learning achievement; the higher the anxiety in learning mathematics, the lower the achievement obtained (Ducay & Alave, 2021). Therefore, it is necessary to know the effect of students' mathematics anxiety on the application of mathematical proficiency in solving problems.

Another influencing factor is the ability to process the information obtained. The ability to process information is known as cognitive independence (Juniati, 2022). Cognitive independence positively

correlates with student learning achievement (Margunayasa et al., 2019). Moreover, it affects the ability to solve mathematical problems (Son & Fatimah, 2020). It can also provide differences in how to solve simple and complex problems, resulting in efficient forms and ways that students of high cognitive independence are better at solving problems than students of low cognitive independence (Juniati, 2022). Therefore, it is important to conduct research related to the effect of cognitive independence on mathematical proficiency in solving problems.

1. 1. Theoretical and conceptual framework

Mathematical proficiency is the goal of learning mathematics. It is a skill that can be used for efficient problem-solving. Thus, it is used as an objective in learning mathematics (Croft, 2017). Mathematical proficiency utilizes the use of efficient strategies and procedural knowledge in solving new problems, and can show a lot of understanding related to concepts in mathematics (Rittle-Johnson et al., 2012). Conceptual understanding can build new knowledge when connecting problem situations with the knowledge that has been possessed (Awofala, 2017) so that it can encourage the development of procedural fluency (Corrêa, 2021). Procedural fluency can be described as choosing efficient and accurate algorithms for computing based on concepts that have been well understood (Awofala, 2017). Strategic competence is related to an individual's ability to elaborate strategies in solving problems by linking them to previous experiences (Qiu & Wu, 2019). Adaptive reasoning skill is used to consider the correctness of strategies used in solving problems logically (Syukriani et al., 2017). Productive disposition is the ability to know mathematics as knowledge connected with daily life and can be understood with perseverance in learning, and thus it can be an amplifier in the development of the other four abilities (Rahman et al., 2022).

Mathematics anxiety is a long-standing focus in psychological and educational research. It is described as an uncomfortable feeling of someone who can hinder the process of number manipulation in solving mathematical problems. Mathematics anxiety can decrease students' confidence, mastery of mathematical concepts, and increase passive anxiety (Rismayana et al., 2021). Furthermore, the feeling of anxiety among students when learning mathematics will negatively affect the students' ability to solve mathematical problems (Juniati & Budayasa, 2021). Excessive math anxiety also impacts students' ability to solve problems in daily life (Caviola et al., 2022).

Cognitive independence reflects the uniqueness of an individual in receiving, remembering, and processing information between cognition and personality (Juniati, 2022). It is the method used in processing information related to how to remember, think, and solve problems (Sudia & Lambertus, 2017). Cognitive independence can provide differences in how to solve simple and complex problems (Juniati, 2022). Therefore, students' learning achievement would be positively affected by it (Margunayasa et al., 2019).

1. 2. Related research

There are four previous research related to this study. A study by Awaji (2021) suggested that in solving problems, only the ability of procedural fluency and productive disposition had a significant effect on other skills that had no impact. The results obtained from the study showed that mathematical proficiency did not develop well. Moreover, a study by Syukriani et al., (2017) assessed that mathematical proficiency of high of cognitive independence subjects tend to be analytical in processing information based on the knowledge they already have while low of cognitive independence subjects are less analytical and cannot recognize the appropriate form of the concept. In a study by Rahman et al., (2022) it was found that subject with high of cognitive independence can use the right strategy in formulating, modelling and solving problems analytically, while the subject of

low cognitive independence uses an incomplete strategy so that it gives the wrong conclusion. The results of the study indicate that different cognitive independence can affect the use of their mathematical proficiency. Finally, Juniati & Budayasa (2022) found that the level of cognitive independence of students has a positive influence on problem solving abilities while mathematics anxiety has a negative effect. The results illustrate that the higher one's level of cognitive independence and the lower the level of mathematics anxiety, the better the students' abilities to solve problems.

1. 3. Purpose of the research

In solving mathematical problems, mathematical proficiency is essential because students learn to choose and use the right strategy in solving problems based on understanding the concepts and formulas in mathematics that are appropriate for the problem situation, explaining the chosen strategy logically, and having a positive view that supports it. Thus, the mathematical proficiency in this study refers to these aspects. Based on some of the research results described, there is a gap as no studies showed the effect of mathematics anxiety and the cognitive independence of high school students towards mathematical proficiency. Therefore, this study seeks to determine and explain the effect of mathematics anxiety and cognitive independence on the mathematical proficiency of high school students in solving problems. In this case, the researchers try to answer the following research questions:

a. Do mathematics anxiety and cognitive independence affect mathematical proficiency?

b. How is the mathematical proficiency of students with math anxiety and different cognitive independence?

1. Methods and Material

2. 1. Research method

The research utilized mixed method, specifically the sequential explanatory design. The method relate to the techniques used for the collection, analysis, and presentation of quantitative and qualitative data (Creswell, 2009). Sequential Explanatory Design was carried out by collecting and analyzing quantitative data based on the results obtained, then collecting and analyzing data and explaining the results obtained qualitatively (Creswell, 2009). This research was divided in two stages: first, quantitative data collection was carried out with the aim of determining the effect of mathematics anxiety and cognitive independence on students' mathematical proficiency. After being analyzed by a multiple linear regression test, the second data collection was carried out qualitatively to explain in more detail the mathematical proficiency of students in solving problems with different mathematics anxiety and cognitive independence using semi-structured interviews.

2. 2. Participants

A total of 455 high school students of SMAN 4 Kendari aged 15-17 years old were involved in this study. The sample selection quantitative data collection used a cluster random sampling technique, which groups all students based on age, namely aged 15 years old, 16 years old, and one student aged 17 years old. Then 155 students were selected from each cluster using simple random sampling. To find out more about the effect of mathematics anxiety and cognitive independence on mathematical proficiency, qualitative research was conducted and the subjects were selected using purposive sampling, which considered the ability of students to communicate and willingness to be interviewed. Four different subjects were selected for their level of mathematics anxiety and cognitive independence. One subject has high mathematics anxiety and high cognitive independence (SIH), one

with high mathematics anxiety and low cognitive independence (SDH), one with low mathematics anxiety and high cognitive independence (SIL), and the last subject with low mathematics anxiety and low cognitive independence (SDL).

2. 3. Data collection tools

Group Embedded Figure Test (GEFT) is used to see the level of students' cognitive independence. GEFT can be used to examine students' ability to focus on finding simple shapes in complex drawings. The GEFT in this study was adapted from Juniati (2022). GEFT, in this study, consisted of 3 parts. The first part had seven questions to be finished in 2 minutes. The second part consisted of 9 questions to be completed in 5 minutes. Finally, the third part had nine questions to be finished in 5 minutes. Students who obtained a score of 0-9 were grouped on low cognitive independence while students with a score of 10-18 were grouped on high cognitive independence (Juniati, 2022). Based on the results of the experts' approval and the trial, GEFT can be declared valid and reliable with a Cronbach alpha value of 0.912. Therefore, it is feasible to use.

Mathematics anxiety questionnaires were used to find out students' feelings about learning and solving mathematical problems. The anxiety questionnaire was used to group the samples into two groups, which were high mathematics anxiety group and low mathematics anxiety group. The low mathematics anxiety group was students who had an average value of mathematics anxiety from 1 to 2.75 while the high mathematics anxiety group consisted of students who had an average value of mathematics anxiety of more than 2.75 (Juniati, 2022). The questionnaire used was an instrument adapted from (Juniati & Budayasa, 2020) which used closed questions consisting 15 items with a Likert scale to show the students' mathematics anxiety with a score of 1 for never, a score of 2 for rarely, a score of 3 for often, and a score of 4 for always. Based on the results of the experts' approval and the trial, the mathematics anxiety questionnaires were declared valid and reliable with a Cronbach alpha value of 0.849. Therefore, it was feasible to use. The mathematics anxiety questionnaires in this study are shown in table 1 below.

Table 1. The Mathematics Anxiety Questionnaires

Aspect	Question items
Anxiety in learning mathematics	• I feel uncomfortable when dealing with material that I don't understand • I feel worried when learning complicated mathematical formulas • I feel that learning mathematics is not as simple as I thought before • I don't feel comfortable when learning mathematics using a computer
Anxiety towards mathematical tasks	• When my friend is asked to solve a problem, I am glad that I am not selected • I get panic when I have to do assignments that are not easy for me • I am afraid to ask my teacher about the things I don't understand • I feel anxious if my friends find out I don't understand or can't answer mathematical problems • I feel uncomfortable when asked to solve math problems and explain them in front of my friends
Anxiety towards mathematical exams	• I panic when there is a math quiz without prior notice • When I study for a math exam, I am anxious if I could not remember the material during the exam • I lose focus in the middle of a math exam and cannot remember the material I have learned before the exam • After finishing the exam, I am worried whether I did good enough in the exam • I am not confident when taking math tests • I am afraid to know the results of my math exam

The mathematical proficiency test used was a test consisting of 10 questions and based on a nationally standardized curriculum. The materials used are three-variable linear equation system, two-variable linear inequality system, composition function, inverse function, trigonometry, linear programs, matrix, geometry, circular equations, arithmetic sequence and series, and transformations. Here, the students' mathematical proficiency is looked based on the aspects of understanding the problem in order to choose the suitable concept, representing the problem to choose the right procedure, solving the problem to apply the procedure correctly, justifying problem-solving, and having a good attitude in problem-solving. Here, the students' mathematical proficiency is looked at based on the aspects of understanding the problem in order to choose the suitable concept, representing the problem to choose the right procedure, solving the problem to apply the procedure correctly, justifying problem-solving, and having a good attitude in problem-solving. The score that the students would get was based on the ability to fulfill these aspects. When students were not successful in fulfilling the aspects, they were given a score of 0. If students could fulfill some of the aspects, then they were given a score of 1. Lastly, when students were successful in fulfilling the aspects, they were given a score of 2. Based on the results of the experts' approval and the trial, the test was declared valid and reliable with a Cronbach alpha value of 0.831. Therefore, it was feasible to use.

The mathematical problem used in this study was a problem that contain geometric material arranged by adding information that could interfere with students' ability to solve the problem. The subjects were given a problem about someone who has tribal land of 100 x 80 meters with each corner having a fish pond measuring 3 x 3 meters, then every day the pond is visited. They were asked about the shortest path and mileage that can be known that can connect the four fish ponds. Based on the results of experts approval and the trial, mathematical problem solving can be declared valid and reliable with a Cronbach alpha value of 0.685. Therefore, it is feasible to use.

Mathematical proficiency questionnaires were used to determine students' attitudes towards learning and solving mathematical problems. The mathematical proficiency questionnaire used was an open question adapted from the research of (Mazana et al., 2018) and (Cerbito, 2020), then revised to suit the language used by the research subject. Furthermore, open ended questions were chosen in order for the students to be able to give answers in their own opinion. Each questionnaire consisted of 9 items to determine the motivation of students in solving problems, mathematical usefulness, and perseverance possessed by students. As approved by the experts, the mathematical proficiency questionnaires was declared feasible to use. The mathematical proficiency questionnaires in this study are shown in table 2 below.

Table 2. Mathematical Proficiency Questionnaires

Aspect	Question items
Motivation to learn mathematics	• Do you have motivation in learning mathematics? • What is your motivation in learning mathematics? • What do you do to increase motivation in learning mathematics?
The usefulness of mathematics	• Do you know the usefulness of learning mathematics in everyday life? • What is the use of mathematics in everyday life? • Why is mathematics useful in everyday life?
Persistence in learning mathematics	• Are you diligent in learning mathematics? • How do you know that you are diligent in learning mathematics? • How can you improve your perseverance in learning mathematics?

2. 4. Data collection Analysis

The quantitative data collected were analyzed with a multiple linear regression test to find the effect of mathematics anxiety and cognitive independence on mathematical proficiency. Multiple linear regression testing shall explain the effect jointly between cognitive independence and anxiety on mathematical proficiency. Multiple linear regression is a model that involves multiple independent variables. It was carried out to determine the direction and the influence of independent variables on dependent variables (Montogomery, 2021). After that, the qualitative data was collected from interview, the results of mathematical problems test, and the results of the mathematical proficiency questionnaires. The analysis of qualitative research data was based on the steps proposed by Miles (2016), namely data categorization, data reduction, data presentation, and drawing conclusions. Data categorization is an activity in grouping data that has the same characteristics. Data reduction is a form of the process of selecting, focusing, simplifying, abstracting, and transforming data. The process of presenting data is to classify data in the form of a set of categorized information. Drawing conclusions can give meaning and explanation between the conformity of the subject statement with the meaning contained in the question. The indicators of mathematical proficiency in this study are shown in table 3 below.

Table 3. The indicators of mathematical proficiency

Aspect	Sub-aspect
Understanding of concepts	• Strategies for choosing concepts that address problem situations • Understand the definition of concepts appropriate for problem situations
Procedural fluency	• Strategies for choosing the right formula • Applying calculations correctly
Strategic competence	• Strategies for understanding known information • Strategies for understanding the information asked • Problem-solving strategies
Adaptive reasoning	• Explain why choosing the strategy used
Productive disposition	• Motivation to learn mathematics • The usefulness of mathematics in everyday life • Persistence in learning mathematics

2. Result

3. 1. The effect of mathematics anxiety and cognitive independence on mathematical proficiency

The first part of the present study, approached quantitatively, was to determine the effect of mathematics anxiety and cognitive independence on mathematical proficiency. The results is presented in table 4 below.

Table 4. Descriptive statistics on mathematical proficiency, mathematics anxiety and cognitive independence

Variable	Minimum	Maximum	Mean	Std. Deviation
Mathematics anxiety (X1)	20	60	2.41	0.46
Cognitive independence (X2)	2	18	5.59	2.55
Mathematical proficiency (Y)	25	100	41.38	12.87

Based on the table above, it is gathered that the average mathematical proficiency is 41.38 with a maximum score of 100, and thus it is classified as fairly high with the lowest value being 25 and the standard deviation which shows an average deviation of 12.87. The result of the cognitive

independence obtained has the lowest value of 2 and the standard deviation of 2.55. In addition, the average value of cognitive independence is 5.59 with a maximum score of 18. Therefore, it can be said that the average participant is classified as having a low level of cognitive independence. The result of mathematics anxiety obtained has the lowest value of 20 and a standard deviation of 0.46. The average value of anxiety is 2.41. Therefore, it shows that the students rarely feel anxious in learning mathematics and working on mathematical problems.

To ensure that the data obtained is feasible, the data must be normally distributed and experience symptoms of homoscedasticity and analyzed using multiple linear regression. The normal probability plot graph is used to determine normal-distributed data which can be seen in Figure 1.

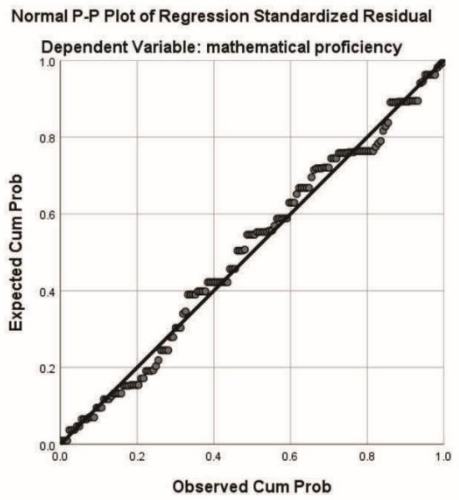

Figure 1. Normal distribution plot

Figure 1 shows the distribution plot of mathematical proficiency values is around the normal line. Therefore, the mathematical proficiency data is normally distributed. Homoscedasticity is used to determine whether the residuals related from one observation to another are fixed. The scatter graph plots of the mathematical proficiency data are presented in Figure 2.

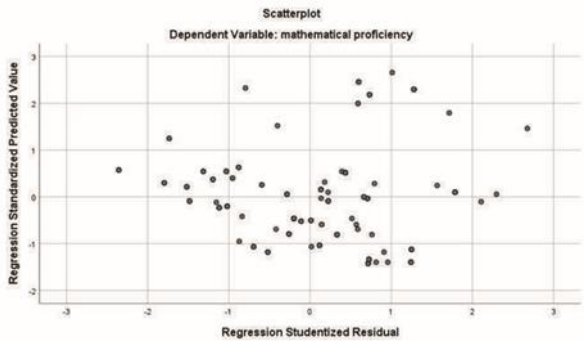

Figure 2. Residual scatter plot graph

In Figure 2, it is shown that there is no special pattern. Furthermore, it is clear that the points are evenly distributed above and below zero on the X axis as well as left and right on the Y axis. As evidently stated, homoscedasticity was found between independent variables (mathematics anxiety and cognitive independence) in the regression model. Based on Figure 1 and 2, it was found that the mathematical proficiency data is normally distributed and evenly distributed. Then, multiple linear

regression analysis was utilized to determine the effect of the independent variables, namely mathematics anxiety and cognitive independence, on the dependent variable, namely mathematical proficiency. The results are presented in Table 5.

Table 5. The results of multiple linear regression coefficient analysis of mathematics anxiety and cognitive independence on mathematical proficiency

		Unstandardized Coefficients		Standardized Coefficients		
Model		B	Std. Error	Beta	T	Sig.
1	(Constant)	33.458	4.620		7.242	0.000
	Mathematics anxiety (X1)	-0.310	0.090	-0.192	-3.463	0.001
	Cognitive independence (X2)	3.567	0.279	0.709	12.797	0.000

Dependent Variable: mathematical proficiency (Y)

Based on table 5, the mathematics anxiety variable (X1) that has a significant value of 0.001 smaller than the significant level of 0.05 means that the mathematics anxiety variable (X1) has an influence on mathematical proficiency. The regression coefficient for mathematics anxiety (X1) is -0.310, and the regression model for mathematical proficiency (Y) is 33.458 - 0.310X1 with a 95% confidence level. The regression model found that mathematical proficiency are negatively and significantly influenced by mathematics anxiety, meaning that the more students' mathematics anxiety, the less mathematical proficiency will be.

The cognitive independence variable (X2) has a smaller significant value than the significant level, meaning that the cognitive independence variable (X2) influences mathematical proficiency. The regression coefficient for cognitive independence (X2) is 3.567, and the regression model for mathematical proficiency (Y) is 33.458 + 3.567X2 with a 95% confidence level. In the regression model, it was found that cognitive independence affect mathematical proficiency positively and significantly. This indicates that the increasing cognitive independence of students also increases mathematical proficiency.

Table 6. Anova based on multiple regression analysis of mathematics anxiety and cognitive independence on mathematical proficiency

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	17933.283	2	8966.642	179.919	0.000[b]
	Residual	7575.258	152	49.837		
	Total	25508.542	1545			

Dependent Variable: mathematical proficiency (Y)

Predictors: (Constant), mathematics anxiety (X1), cognitive independence (X2)

Table 7. The results of multiple linear regression coefficient analysis of mathematics anxiety and cognitive independence on mathematical proficiency

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.838[a]	0.703	0.699	7.059

In the above table, the value of multiple R is 0.838. On the other hand, in table 6, the results obtained is a value smaller than its significant level of 0.000. Therefore, it can be concluded that

mathematics anxiety and cognitive independence simultaneously affect mathematical proficiency. In table 7, the R square value is 0.703, which shows that 70.3% of mathematics anxiety and cognitive independence simultaneously affect mathematical proficiency while 29.7% explain other things.

Based on several descriptions that have been explained, there is a significant influence of mathematics anxiety and cognitive independence on mathematical proficiency. If the lower the score of mathematics anxiety and the higher the value of cognitive independence obtained, the mathematical proficiency used in solving the problem will increase.

3. 2. Description of the effect of mathematics anxiety and cognitive independence on mathematical proficiency

Data collection was carried out by providing a mathematical question about strategies for connecting the fish ponds through interviews with the subjects based on the results of solving questions on mathematical proficiency questionnaires.

SIL and SDL can used their mathematical proficiency to the maximum so that they can solve the given problem. SIL and SDL used the strategy of writing sentences that had numbers on the problem to obtain information that was known in full and used the strategy of writing sentences that had question marks on the problem to obtain the information that was asked in full. SIL used a strategy of imagining the problem situation completely while SDL used the strategy of imagining and describing the problem situation completely to choose the concepts of rectangle and square. SIL and SDL explained in full using the image that the definition of a rectangle is a building that has two pairs of parallel lines and a square is a building that has sides that are equal in length. SIL solved the problem analytically by making a line that connects all fish ponds so as to form a rectangle and then separating them and making a diagonal line so as to form a triangle of elbows while SDL solved the problem intuitively by trying several roads connecting all fish ponds diagonally. SIL and SDL did calculations based on the Pythagoras formula correctly so as to obtain the appropriate conclusion that the shortest road that connects all fish ponds is 239,63 meters. SIL and SDL explain the reasons for using these strategies logically. SIL and SDL often have a positive outlook on learning and solving mathematics tasks. SIL's mathematical proficiency process can be shown in the following figure 3.

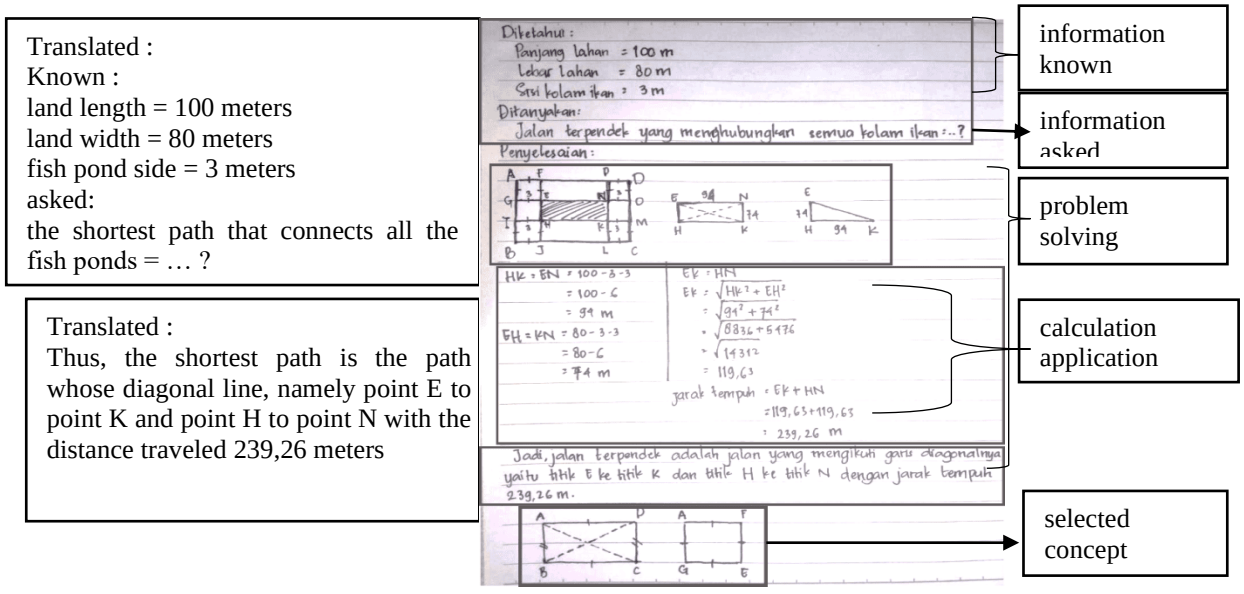

Figure 3. SIL's mathematical proficiency process in solving problem

SIH and SDH have not been able to use their mathematical proficiency optimally so they cannot solve problems. SIH and SDH understands the information is known in full using the strategy of writing and describing sentences with numbers on the problem and monitored the information asked in full by using the strategy of writing sentences that have complete question marks. SIH and SDH also use the same strategy of imagining and describing the problem situation completely to chose the concept of square and rectangle. SIH and SDH fully explained that a rectangle is a rectangular building that has a length and a width while a square is a building with all sides being equal in length. SIH and SDH solved the problem intuitively by trial-and-error, trying roads that can connect all fish ponds incompletely so can't determine the shortest path. SIH choosing the formula Pythagoras to determine the length of the diagonal line and applied the appropriate calculation to obtain a distance of 267.63 meters. SDH choosing the perimeter formula of the rectangle and applies the appropriate calculation so that it obtains a distance of 336 meters. SIH and SDH explain the reasons for using these strategies logically. SIH often has a positive outlook on learning and solving mathematics tasks whereas SDH rarely has a positive outlook learning and solving mathematics tasks. SIH's mathematical proficiency process can be shown in the following figure 4.

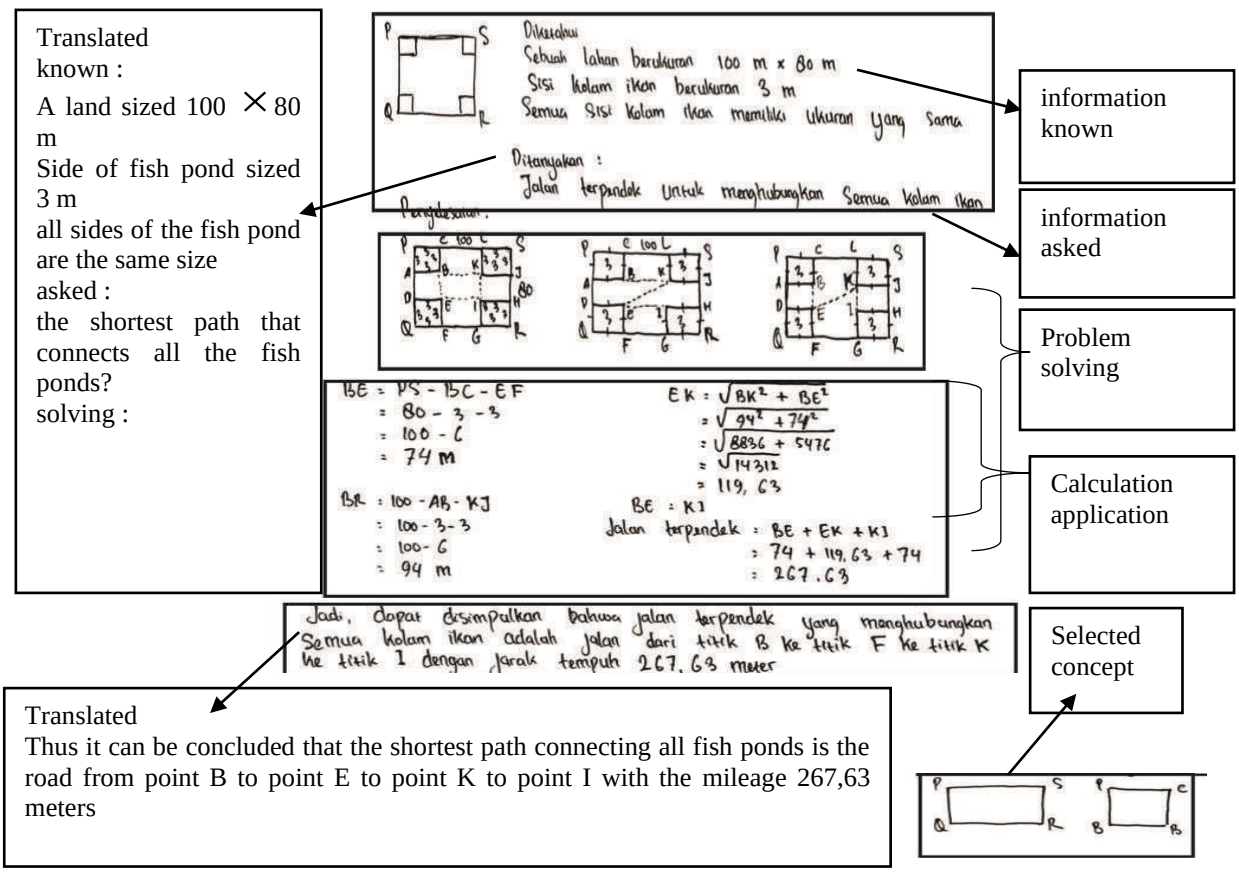

Figure 4. SIH's mathematical proficiency process in solving problem

3. Discussion

It can be said that the level of mathematics anxiety affects students' mathematical proficiency negatively and significantly. The higher the student's anxiety, the lower the mathematical proficiency used in solving problems. Furthermore, students possessing high mathematics anxiety tend to have negative attitude that correlates with their ability to solve problems, namely choosing the appropriate concept intuitively as information that suddenly appears in their mind, describing the relationship of concepts and situations incompletely but can choose the right formula, solving problems with trial and error strategies but cannot provide the correct conclusions and cannot explain the reasons for selecting strategies logically. Students with low mathematics anxiety have a positive attitude in supporting mathematical proficiency, namely using efficient strategies in understanding the situation contained in the problem, using mental representations of the knowledge that has been possessed, and understanding the problem situation to obtain concepts and formulas that are in accordance with the problem situation analytically. They could provide logical reasons for using the selected strategies and apply calculations precisely based on the formulas chosen to give the correct conclusions. Increased anxiety can hinder students' ability to view learning mathematics positively and use logical strategies in choosing concepts and formulas appropriate for the problem in solving the problem at hand. The results of this study are in line with (Juniati, 2022), which shows that high anxiety can make students' minds experience a stalemate so that they cannot choose strategies to solve problems, and (Zhang et al., 2019), which shows that high school students who have high anxiety affect their thinking skills so that they cannot complete tasks.

On the other hand, cognitive independence has a significant and positive effect on students' mathematical proficiency. Therefore, the higher the students' cognitive independence, the higher the use of mathematical proficiency in solving problems. Students with a high level of independence have a positive tendency to use analytical, effective, and efficient strategies in managing the complete and whole information related to problem situations, as well as the knowledge possessed about concepts, formulas, and their application in solving problems. Students with a low level of independence have a negative view of using strategies that tend to be intuitive and inefficient. Therefore, managing information is incomplete and intact related to understanding the problem situation and managing knowledge that is also incomplete and intact, providing inaccurate conclusions but choosing concepts and formulas appropriate to the problem situation. The higher the person's cognitive independence, the more analytical method is used in processing knowledge and understanding problem situations. In comparison, the lower the student's mental autonomy, the more intuitive it will be. This study's results align with (Zolkower et al., 2020), who found that students high level of cognitive independence can recognize their experience capacity in elaborating in-depth information on the problem, and (Son & Fatimah, 2020) that students high level of cognitive independence tend to be independent and confident in solving problems. Then, the ability of students to manage information in a low levels of independence manner can make them use strategies intuitively and illogically in independently processing the knowledge that has been possessed related to concepts and formulas that are appropriate to the problem situation so that it does not obtain effective and relevant solutions. This assertion is in line with (Mamonto et al., 2018) study, which suggests students with low level of independence are difficult to process information and lack of knowledge restructuring.

4. Conclusion

The level of anxiety of students towards learning and solving mathematical problems has a negative effect on mathematical proficiency. High mathematics anxiety makes students use trial and error strategies in solving problems. Meanwhile, low level of mathematics anxiety makes students use

more analytical strategies. Increased anxiety can prevent students from using mathematical proficiency to the maximum, so they cannot provide solutions in accordance with problem-solving. Mathematics anxiety is one of the factors that can hinder students' ability to use strategies to select and connect concepts and problem situations, as well as the selection and application of effective formulas.

Cognitive independence positively influences mathematical proficiency. Students with a high level of cognitive independence can process information obtained independently, namely processing their knowledge and using effective and efficient strategies to solve problems faced analytically and logically. In contrast, students with a low level of cognitive independence can process information obtained in a dependent manner, which tends to require the help of others, and use problem-solving strategies intuitively and illogically. Low cognitive independence can hinder the maximum use of mathematical proficiency in solving problems.

5. Recommendations

The results of this study support previous researches that mathematics anxiety and cognitive independence play a role in students' mathematical proficiency. In planning the learning process, teachers should consider the characteristics of students with high or low mathematics anxiety who can process information independently or with the help of others. In addition, teachers can strive for learning activities that support students with low independence levels and high anxiety to achieve success in learning better mathematics.

This research is limited to knowing the general view of the effect of cognitive independence and mathematics anxiety levels on the mathematical proficiency of high school students. Further studies are needed to explore difficulties experienced by students, especially those with high mathematics anxiety and low level of independence, and find solutions to overcome this.

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