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Students Mathematical Literacy Level in Solving PISA-based Problems Shape and Space Content: An Analysis from the Perspective of Self-concept Mathematics

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ABSTRACT

Literacy skills are a major component of 21st-century learning. Mathematical literacy is a person's ability to formulate, reason, implement, and solve problems in real-world contexts appropriately and regularly. The purpose of this study was to analyze the mathematical literacy ability of 28 grade IX students in shape and space content reviewed from the mathematic self-concept. One of the difficult materials in mathematics is shape and space because students need a deep understanding of concepts and the ability to visualize problems into sketches or geometric drawings. The difficulties experienced by students have psychological factors that influence one of them is self-concept mathematics. This study used qualitative research methods with stages of giving tests, filling out questionnaires, and structured interviews. The subjects of this study were 28 students of grade IX A MTs PPMI Assalaam Sukoharjo. Data analysis techniques use techniques from Milles and Huberman. The results obtained from this study are students with high self-concept mathematics, their mathematical literacy skills are high because they are able to meet the indicators of formulating problems, using concepts, and analyzing mathematical results in a real-world context. In students with moderate self-concept mathematics, moderate mathematical literacy ability is because they are only able to meet the indicators of formulating problems and using concepts, while students with low self-concept mathematics are low in mathematical literacy skills because they are only able to meet indicators using mathematical concepts. This research can be used as comparison material in students' mathematical literacy according to their psychological condition.

Keywords: *Mathematical Literacy, Self-Concept, Shape and Space, PISA*

Tingkat Literasi Matematika Siswa dalam Menyelesaikan Soal Berbasis PISA Konten *Shape and Space*: Analisis dari Perspektif *Self-concept Mathematics*

ABSTRAK

Pembelajaran abad 21 merupakan pembelajaran yang menjadikan literai sebagai komponen utama. Literasi matematika merupakan kemampuan seseorang untuk merumuskan, menalar, mengimplementasikan dan memecahkan masalah dalam konteks dunia nyata secara tepat dan teratur. Tujuan Penelitian ini adalah menganalisis kemampuan literasi matematika 28 siswa kelas IX dalam konten

shape and space yang ditinjau dari *self concept mathematic.* Salah satu materi sulit dalam matematika yaitu *shape and space* karena siswa memerlukan pemahaman konsep yang dalam dan kemmapuan untuk memvisualisasikan permasalahan ke dalam sketsa ataupun gambar geometri. Kesulitan yang dialami siswa memiliki faktor psikologi yang mempengaruhi salah satunya *self-concept mathematics.* Penelitian ini menggunakan metode penelitian kualitatif dengan tahap pemberian tes, pengisian angket, dan wawancara terstruktur. Subjek penelitian ini ialah 28 siswa kelas IX A MTs PPMI Assalam Sukoharjo. Teknik analisis data menggunakan teknik dari Milles and Hubberman. Hasil yang didapatkan dari penelitian ini ialah siswa dengan *self-concept mathematics* tinggi maka kemampuan literasi matematikanya tinggi karena mampu memenuhi indikator merumuskan masalah, menggunakan konsep, dan menganalisis hasil matematika ke dalam konteks dunia nyata. Pada siswa dengan *self-concept mathematics* sedang maka kemampuan literasi matematika sedang karena hanya mampu memenuhi indikator merumuskan masalah dan menggunakan konsep, sedangkan siswa dengan *self-concept mathematics* rendah maka kemampuan literasi matematika rendah karena hanya mampu memenuhi indikator menggunakan konsep matematika. Penelitian ini bisa digunakan sebagai bahan perbandingan dalam literasi matematika siswa sesuai kondisi psikologisnya.

Kata Kunci: *Literasi Matematika, Konsep diri, Bangun dan Bentuk, PISA*

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1. Introduction

At this time we live in a time of tremendous change with very rapid technological development. New knowledge, tools, and ways of doing and communicating mathematics are growing. The development of this technology cannot be separated from mathematics because science is used to operate a program(Daring et al,.2023). This is reinforced by the *National Council of Teachers of Mathematics (NCTM*) that mathematics is a necessity because becoming an intelligent society requires mathematical foundations and thoughts for problem-solving (Ferrini J et al., 2000). The purpose of mathematics according *to the National Council of Teachers of Mathematics (NCTM)* is the ability to solve problems, reasoning, mathematical communication, and mathematical connections (Krisner et al., 1993) .

In line with the above, the *Organization for Economic Co-Operation Development (OECD) through the* Program For International Student Assessment *(PISA) conducted an ability test of 15-year-olds in students' reading, mathematics, and science literacy* [(OECD, 2019). Mathematical literacy is the ability of individuals to reason mathematically, formulate, implement, and analyze problems to find a solution in a real-world context(OECD, 2013). This helps individuals to know the important role of mathematics in the real world that humans need in the 21st century (OECD), 2023). Simply put, mathematical literacy is the ability to understand and use mathematics in various social contexts to solve problems and be able to explain mathematics to others (Abidin Yunus et al.,2015). So it can be concluded that mathematical literacy is a person's ability to formulate, reason, implement, and solve problems in the real-world context appropriately and regularly.

The 21st-century learning is learning that combines literacy, knowledge, and technology(Rahayu et al., 2022). Thus, literacy skills are a major component of 21st-century learning (Rambe et al., 2023). The Indonesian state has taken this PISA Exam since the beginning of the program. From several exams, Indonesia gradually rose to a higher rank. Based on the PISA report, Indonesia's ranking in Mathematical Literacy increased by 5 to 6 points compared to the previous year (*Pisa 2022*, 2023). Although it has increased, mathematics literacy in learning in Indonesia still has to be done. Because, according to a statement delivered by Hapsari (2019), the level of student literacy is still low because students are not used to solving math problems in everyday contexts and students lack understanding of mathematical concepts. Understanding this concept will help students understand advanced material and help students solve problems both in mathematics and everyday life (Radiusman, 2020). So it can be concluded that mathematical literacy is a person's ability to formulate, reason, implement, and solve problems in the real-world context appropriately and regularly.

The test conducted by PISA consists of several mathematical contents, namely: change and *relationship,* space and shape*,* quantity, and *uncertainty* (Susilo & Sutarto, 2023). Of the four components above, geometry is still one of the difficult materials for students (Sari & Roesdiana, 2019). These difficulties are students' inability to state the terms and meanings used to represent the concept of an object, difficulties in applying geometric principles, and students' difficulty in using geometric concepts and principles(Fauzi & Arisetyawan, 2020). In line with this, according to Susanto & Mahmudi (2021), students must have mature concepts to be able to apply geometry concepts well, such as visualizing, recognizing various pieces, describing, and sketching(Susanto & Mahmudi, 2021). Another difficulty that students have is their inability to determine factors that are by geometry problems and students' inability to apply concepts (Alamsyah, 2016).

Shape and space material often known as geometry material is a very important material in learning. Geometry or *shape and space* teaches students problem-solving skills and geometry material has connections to other materials (Budiarto & Artiono, 2019). Geometry has a section on other materials such as architecture, art, and all objects made by humans there are aspects of geometry that can provide inspiration for student problem-solving (Malasari et al., 2017). Not only that, *shape* and space material can develop students' visual skills from shapes and relationships in space (Carter N,2021). The above statement is in line with Brumfiel's opinion, 1960 (in Susilo & Sutarto, 2023) that geometry can develop logical rigor and help someone understand and develop scientific thinking(Susilo & Sutarto, 2023).

The difficulties that these students have are several influencing factors, such as psychological factors. The psychological factor *is self-concept, self-concept* is a person's image of himself. Meanwhile, Carl R. Rogers in the book Burns (1979: 39) states that *self-concept* is an orderly form or arrangement of self-perceptions. An individual's perception of the characteristics possessed, the individual's perception of the relationship between himself and others and the surrounding environment, the perception of his qualities related to his experience and the object faced, and goals and ideals that are perceived as something positive and negative. *Self-concept mathematics* in students influences academic achievement and interest in subjects (Möller et al., 2020). Other studies state that students who have high and medium *self-concept* tend to have better performance than students who have low *self-concept* (Sultra et al., 2018).

According to Calhoun and Acocella indicator *self-concept mathematics*, namely a.) Knowledge., at the moment when a person finds out about himself. b.) Hope is when a person has an idea of who he is and the possibility that happens to him about something that happens in the future. c) Assessment, when the individual can assess himself in terms of achievements, expectations, contradictions in himself, and the standard of living that suits him which means how much someone likes him(Susilawati et al., 2020). In learning mathematics, not all student

have the same ability when solving PISA-Based Problems Shape and Space Content. Solving mathematics problems is influenced by self-concept, because self-concept has a important and direct effect on mathematics ability, not only cognitive aspects but also motivation aspects.

Based on the description that has been submitted above, the researcher is interested in exploring and analyze students' mathematical literacy skills in shape and space content reviewed from mathematic self-concept. This study used subjects of grade IX boarding school students who had different habits from other students, so by knowing their level of mathematics literacy and self-concept can improve school achievement. It can be used as a reference to determine educational and occupational choices. Therefore, it is necessary to review and improve students' abilities in mathematical literacy during the mathematics learning process.

2. Methods

The research method used is qualitative research. Qualitative research is research based on the philosophy of post-positivism used to examine natural conditions (Sugiyono, 2013). This research uses qualitative descriptive methods to describe the results of the research that has been done.

The subjects studied amounted to 28 students of class IX A MTs Assalaam Sukoharjo. Subjects selected in interviews used *purposive sampling* techniques by research criteria to assist researchers in finding information (Creswell, 2015). The analysis used uses Milles and Huberman (1984) by reducing data, then presenting data, and verifying or drawing conclusions (Sugiyono, 2013).

In the research process, there are three instruments carried out by researchers, namely: 1) mathematical literacy ability tests, 2) *Self-Concept Mathematics questionnaires,* and 3) structured interviews. The questions used in the math literacy proficiency test were adopted from the previous year's PISA questions. In mathematical literacy, some indicators must be achieved to evaluate literacy ability. Indicators of literacy ability can be seen in Table 1.

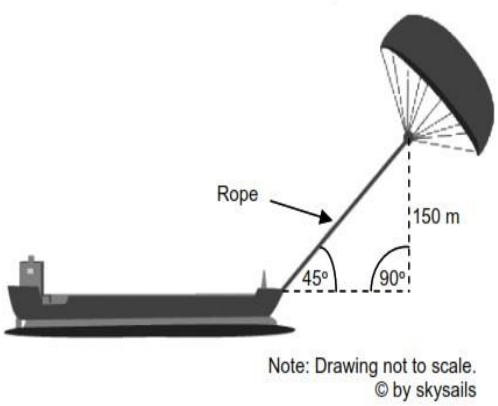
Table 1. Mathematical Literacy Indicators

Indicator	Valuation
Formulate known problems in the problem	Students can find facts that are in the problem.
Using mathematical concepts	Students can use and transform problems into rules, algorithms, structures, and mathematical images to find solutions to problems.
Analyze results in real-world contexts	Students can analyze and provide conclusions of mathematical results in real-world contexts.

Source: OECD, 2018

The questions tested in the study adapted from (OECD, 2013) in *PISA 2012 Released Mathematics Item* can be seen below:

> *A ship belonging to the TNI-AL was used for a naval anniversary parade. The ship will fly a kite from the top of the ship as pictured. To fly the kite, what is the length of the kite rope so that the ship can pull by 45 the degree vertical height of the kite against the base of the ship is 150 cm.*



Picture 1. Math Literacy Problems

In the self-concept mathematics questionnaire, there are 21 questions consisting of positive and negative statements. Self-concept mathematics categorization uses the Likert scale where the maximum score of each question is 4 and the minimum score is 1. Thus, students are able to meet a minimum score of 21 and a maximum of 84. The self-concept grouping can be seen in the table below.

Table 2. *Self-Concept Mathematics*

Score	Ability
64-84	High
43-63	Medium
21-42	Low

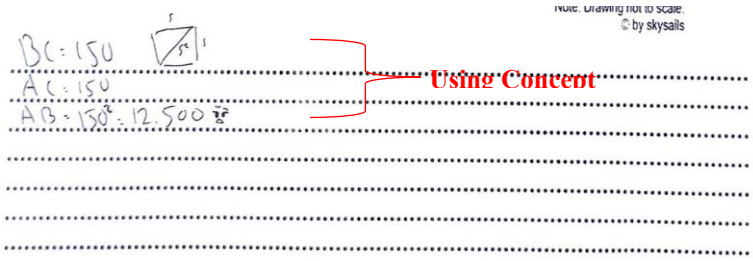
3. Result and discussion

This study aims to determine students' mathematical literacy abilities in terms of students' *mathematic self-concept* as seen from student achievement in meeting literacy indicators. The achievement is divided into three categories, namely students with high literacy, students with medium literacy, and students with low literacy. Students with high literacy skills can solve problems by meeting the indicators of men. Then students who have moderate literacy skills only meet two indicators. Meanwhile, students with low literacy skills only meet one indicator.

After being given questions about mathematical literacy, students were given a questionnaire to measure mathematical *self-concept* consisting of 21 questions. *Self-concept* mathematics is divided into *students with high self-concept mathematics, students with moderate self-concept mathematics, and students with* low *self-concept* mathematics. The results *of the self-concept mathematics test were represented by three students, each of whom was given the code C1* for the answers of students with low self-concept mathematics abilities, C2 for the answers of students with moderate self-concept mathematics, and C3 for the answers of students with *high* self-concept mathematics. The results of these subjects can be seen below.

3.1 Subjects with *Low self-concept mathematics (C1)*

Based on the research conducted, here are the answers to Subject C1:



Picture 2. Subject Answer C1

The answers of these students need to be supported by interviews. The following interview results are presented to represent the stage of solving questions from researchers to subject C1. Questions are coded P and answers from subjects are coded C1.

P: " What information do you understand in that context?
C1: "The height of the kite is 150m"
Q: "What is the problem asked in the question?"
C1: "The length of the rope mba"
Q: "So, what concept do you use to solve the problem?"
C1: "Use the square of mba, because I don't understand the meaning of the problem"
Q: "Try the steps to find the answer"
C1: "From the picture, it's 150 mba, so I used it ABC triangle image then AC and BC length is 150 cm and stayed with the MBA to find the sloping side."
Q: "Then what conclusion do you get from the answer?"
C1: "The Voice of the Devil"
Q: "Can the problem be solved using other concepts?"
C1: "I don't know mba"

Formulate a problem

Using concepts

Analyze mathematical results

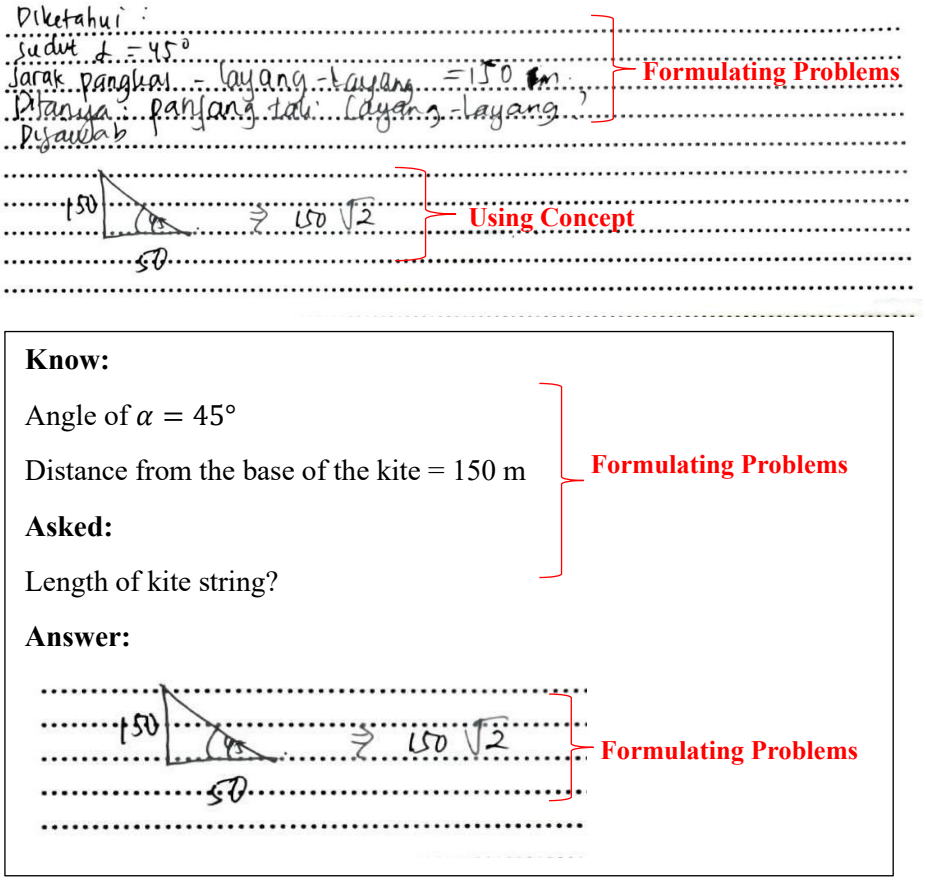
In the problem formulation indicator, it shows that subject C1 can write down the facts in the problem and subject C1 can determine the problem asked in the problem. This is reinforced by interviews where subject C1 can state what is known and asked about the problem.

In the second indicator, mathematical concepts are used, showing the results of the C1 subject test using quadratic rules with clarity through pictures. However, in finding the correct completion result, the concept of Pythagoras is needed by looking at the hypotenuse to find results. Thus, subject C1 skipped the stage. This is reinforced by the results of the interview of subject C1, he was able to explain again the steps he used to find the results of the settlement. Although subject C1 can use mathematical concepts in problem-solving, the answers given are not correct.

In analyzing mathematical results in real-world contexts, the test results of subject C1 show that the subject has not been able to achieve these indicators. Subject C1 does not know what conclusions he has reached in the problem. This is reinforced by the results of the interview, that subject C1 has not been able to find conclusions from the problems given. Based on the above explanations, subject C1 is only able to meet the indicators in formulating the problem.

3.2 Subjects with Moderate Self-Concept Mathematics (C2)

Based on the research that has been done, the answer to subject C2 can be seen in the picture below:



Picture 3. Subject Answer C2

With these answers, researchers reinforced the results by conducting interviews with C2 subjects. The following interview results are presented to represent the stage of solving questions from researchers to C2 subjects. Questions are coded P and answers from subjects are coded C2.

P: " What information do you understand in that context?"
C2: "The angle is 45° and the kite rope height is 150 m"
Q: "What is the problem asked in the question?"
C2: "The length of the kite rope"
Q: "What concepts do you use to solve problems?"
C2: "Pake pyhtagoras"
Q: "What formula did you use to solve the problem?
C2: "Pythagoras"
Q: "What is the conclusion of the answer you got?"
C2: "The triangle that is 45 must be one of the corners of 90°° the hypotenuse must be" $\sqrt{2}$
Q: "Can the problem be solved using other concepts?"
C2: "Maybe, but I don't know"

Formulating Problems
Using Concepts
Analyze results mathematics

In the problem formulation indicator, the test results of subject C2 show that subject C2 writes down the things that are known and asked in the problem. This is reinforced by the results of the interview, that subject C2 can restate the facts known and asked in the question.

The test results for subject C2 show that subjects can meet indicators using mathematical concepts. Judging by the answers of subject C2, he was able to use known facts to use at a

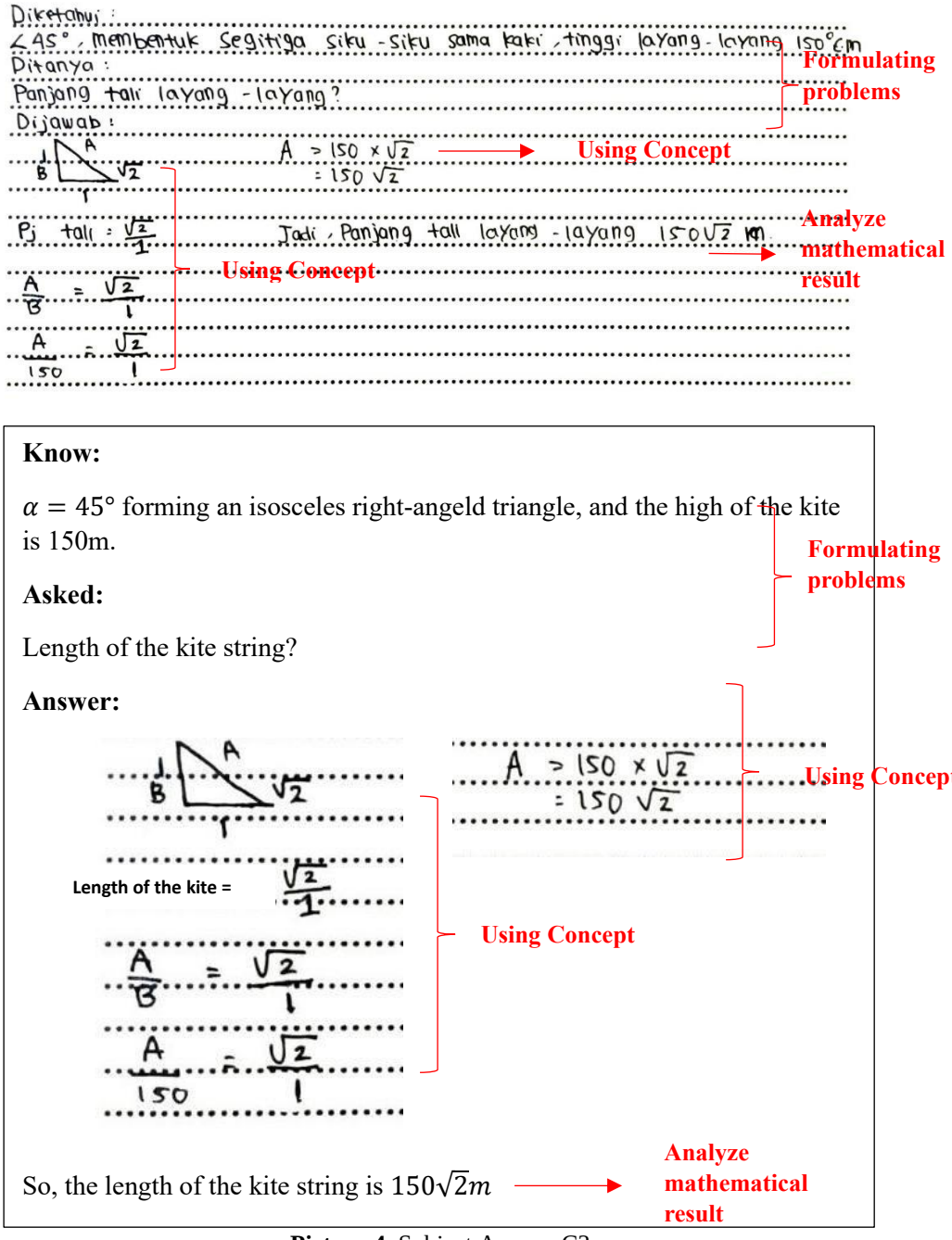
later stage. It is then converted into an image using the rules of phytagoras and from the image the subject is used to assist himself in finding results. This is reinforced by the interview results that subject C2 was able to explain again the steps he used in finding solutions.

In the indicator of analyzing mathematical results, the test results of subject C2 show that the subject has not been able to achieve the indicator. Subject C2 did not write down the conclusions he came to. From the interviews, subject C2 only mentioned the way it was done in finding the results of the settlement. So, the answer given is not quite right.

Based on the explanation above, subjects with subject C2 are only able to meet the indicators of formulating problems and using mathematical concepts only.

3.3 Subjects with *High Self-concept Mathematics* (C3)

Based on the research, the results of the answers from subject C3 can be seen in the picture below.



Picture 4. Subject Answer C3

To strengthen the results of the study, interviews were conducted on C3 subjects. The following interview results are presented to represent the stage of solving questions from researchers to C3 subjects. Questions are coded P and answers from subjects are coded C3.

P: " What information do you understand in that context?"
C3: "Angle 45° and the height of the kite 150 m"
Q: "What is the problem asked in the question?"
C3: "Looking for the sloping side or length of the kite rope"
Q: "What concepts do you use to solve problems?"
C3: "Use angular ratio, but if on certain numbers usually use triple Pythagoras"
Q: "What formula did you use to solve the problem?
C3: "For example, if there is A that has not been studied and then B that is already known, it will be
the $\frac{A}{B} = \frac{\sqrt{2}}{1}$. *Then B is already known to be 150 so then just cross multiply"*
Q: "Where did you meet him from $\sqrt{2}$*?"*
C3: "From diagonal rectangle mba"
Q: "What is the conclusion of the answer you got?"
C3: "So the length of the rope in question is $150\sqrt{2}$ *m"*
Q: "Can the problem be solved using other concepts?"
C3: " Phytagoras triple if the numbers used to match, otherwise, use comparison"

Formulating Problems
Using concepts
Using concepts
Analyze mathematical results

In the first indicator of problem formulation, subject C3 writes down what is known and asks about the problem. This is reinforced by the results of the interview of subject C3 that he was able to restate the facts in the question.

In the second indicator, namely the use of concepts, subject C3 was able to use the concepts of Pythagoras and comparisons to find the results of completion. This is reinforced by the results of interviews that have been conducted, that subject C3 can explain again the steps he uses to find solutions. Subject C3 is also able to provide other alternatives to find a solution.

The third indicator analyzes mathematical results in a real-world context, subject C3 provides conclusions on the results of the solution. Reinforced by the results of the interview, subject C3 was able to state the conclusions he had obtained by combining them in a real-world context. Based on the results of the above analysis, C3 subjects can meet the indicators of formulating problems, using counsel, and analyzing the results in a real-world context.

From the results of research that has been done, it is found that students with low self-*concept mathematics* are only able to formulate problems. Although the students' answers use the concept of *Pythagoras*, determining the results requires other concepts. So, the answers given by students are not quite right. Test results given by students with low *self-concept mathematics* show that students have achieved problem formulation indicators. This is reinforced by interviews that have been conducted, students stated that students did not understand the material provided so it affected the results written by students. The student's lack of understanding of the questions given affects students in determining the steps to solve the problem, so the concepts used and the answers given are not appropriate (Ratri & Setyaningsih, 2020). The opinion expressed by (Jainuri et al., 2020) if *self-concept mathematics* is low then students' understanding of mathematics is also low. The factors that cause students to have *low self-concept mathematics* are having a feeling that they are not smart and incompetent, lack of intrapersonal experience, and someone has a sense of lack of image (Novarianing Asri et al., 2020). Meanwhile, states that another factor that influences students to have low *self-concept* is that someone feels that he is not noticed by others, someone considers that criticism from others is an attempt to bring himself down (Alamsyah, 2016).

Self-concept mathematics *students* can solve problems well. However, students with *moderate self-concept mathematics* are only able to achieve two indicators, namely formulating problems and using concepts. This is in line with the opinion expressed by (Muslimah & Pujiastuti, 2021) that students with medium literacy ability categories can reach level 3, namely, students can identify problems and solve problems using formulas and can choose appropriate problem-solving strategies. It can be seen in interviews that students with self-concept mathematics can provide information about the problem and can mention the method they use to solve the problem. Students with self-concept mathematics can understand the material well (Putri & Azmi, 2023).

Meanwhile, students with high self-concept mathematics have good abilities in understanding problems and solving problems, and there is little concern experienced by students about learning mathematics (Makmur et al., 2021). This can be seen from the results of students with high self-concept mathematics can solve problems well. Judging from the answers of students with high *self-concept mathematics,* they can state what is asked and what is known in the problem. Then in the next stage, students can convert the problem into mathematical form using the concept of comparison. Students can also provide conclusions on problems that have been solved. It can also be seen at the interview stage, that students with high *self-concept mathematics* have good abilities with mathematical material. Students can find alternatives that can be used to solve problems. This is in accordance with the statement stated by (Nuringtyas & Setyaningsih, 2023) that students are able to use good reasoning and reasoning skills So, if someone has a high *self-concept in mathematics,* then the ability of students to understand mathematics lessons is also good. This is in accordance with the statement given by (Siregar & Rajagukguk, 2023) that the better the self-concept or *self-concept* possessed, it will encourage the ability to understand mathematical concepts.

4. Conclusion

Self-concept is crucial for the success in learning mathematics in school where each student has different abilities. Based on the research that has been done, it can be seen that students with *high self-concept mathematics* are able to meet the indicators of formulating problems, using concepts, and analyzing mathematical results in real-world contexts. Students with *moderate self-concept mathematics* are able to meet the indicators of formulating problems and using concepts only. Meanwhile, students with *low self-concept mathematics* are only able to meet one indicator, namely using mathematical concepts. So it can be concluded that students with *high self-concept mathematics* have high mathematical literacy, while students with *moderate self-concept mathematics* have medium mathematical literacy as well, and students with *low self-concept mathematics* have low mathematical literacy abilities. Based on the results above, psychological factors owned by students affect their academic abilities and views on a mathematic lesson.

5. Acknowledgement

Based on the research that has been done, the author hopes that the research that will be carried out next is able to examine subjects with self-concept mathematics broadly and more deeply. As for teachers, it is expected to be able to understand and know the self-concept of mathematics owned by students.

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