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Analysis of Mathematics Literacy Ability in Solving PISA-type Questions viewed from Students' Mathematical Disposition

Dimas Hudda Satriani[1*], Yuyu Yuhana[2], Etika Khaerunnisa[3]

[1,2,3]Department of Mathematics Education, Sultan Ageng Tirtayasa University, Indonesia
*Corresponding Author: dimas7795@gmail.com

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ABSTRACT

The purpose of this research intended to described the qualities of students' mathematical dispositions and mathematical literacy in response to PISA-style questions. This research uses qualitative approaches and also incorporated within the qualitative descriptive research. The 39 students in class 10 MIPA who participated in the research were then reduced to three students to represent the low, medium, and high levels of disposition. The data were gathered using a questionnaire that measures students' mathematical disposition, a written essay test that measures students' mathematical literacy, and direct interviews. The outcome revealed that seven students fell into the low mathematical disposition category, 24 students had medium mathematical disposition, and eight students had high mathematical disposition. On the PISA scale of mathematical literacy, students with low mathematical disposition earn level 2, students with medium mathematical dsiposition achieved level 4 whereas those with strong mathematical disposition obtain level 6.

A. INTRODUCTION

Education is an important aspect of supporting life. Education is a need that must be met by everyone. Education is a key component of a country. A generation that is intelligent and skilled in their profession will be produced through quality education, and it is this skilled generation that will be responsible for the improvement and progress of the country's condition (Rokhmawati et al., 2019). Education has the power to provide students with practical information and life skills that will benefit them throughout their lives. Mathematics is a subject that is practical and of great benefit in life. All humans need to understand mathematics, as a result, mathematics is taught at all levels of education, both primary, secondary and even higher education (Zamnah & Ruswana, 2018). The existence of mathematics is very important so learning mathematics requires consistency and continuity. The presence of mathematics at various levels of education indicates that students need to be equipped with the ability to make decisions, read, write, think logically, systematically, analytically, critically, creatively, cooperatively (Sulasdini & Himmah, 2021). This ability is needed to prepare students to face the changing times that are very fast and competitive. This ability is called literacy ability. Literacy is defined as a person's capacity in language, including the ability to listen and communicate, both orally and in writing in a manner appropriate for the intended communication purpose (Sari & Pujiono, 2017)

In mathematics there is also literacy. Mathematical literacy emphasizes how to make the most of mathematics in social life. Research in Kediri assesses that every individual who has high literacy skills not only understands mathematics, but is able to apply it to life (Muzaki & Masjudin, 2019). Utilization of mathematics can go through several processes starting from finding out, identifying, associating, formulating, thinking and other mathematical cognitive processes. The ability to develop, use, and draw conclusions from mathematics in a variety of real-world settings where problems need to be solved can be referred to as mathematical literacy (Novita Sari & Wijaya, 2017).

The very essential mathematical literacy ability is not in line with the results shown by Indonesia on the world stage. Mathematical literacy has a global standard assessment called the Program for International Students Assessment (PISA). PISA 2018 showed bad results for Indonesia. In the mathematics category,

Indonesia was in the bottom position. The average score for Indonesia, which ranks 73rd, is 379. It was at level 1, the lowest level of the six levels of literacy ability determined by PISA, that Indonesia can achieve. The absence of students' curiosity, interest, or enthusiasm in mathematics is one of the reasons for the low level of mathematical literacy in Indonesia. Strong inclination and interest in mathematics can form mathematical disposition (Widyasari et al., 2016). The lack of basic math skills possessed by students is the cause of their low level of mathematical literacy (Hasnawati, 2016). Low student literacy is also caused by the lack of independent learning in students (Babys, 2017).

Due to their poor mathematical disposition, students struggle to think critically and act positively toward mathematics (Suryaprani et al., 2016). According to Mahdiansyah in Suryaprani (2016) found that low mathematical literacy Indonesian students are not solely because of their solving abilities the problem of students who are lacking or his appreciation of mathematics not enough. Instruments used in PISA is the applicable instrument internationally and not specifically adapted to Indonesian conditions. This means that although the disposition of mathematics or students' appreciation of mathematics is quite high, in the context of students who do not understand it, students' mathematical literacy will be low. A positive attitude (disposition) towards the use of mathematics in daily life, such as curiosity, attention, and interest in studying mathematics as well as tenacity and confidence in problem-solving, can be developed by students who have strong mathematical literacy skills (Suryaprani et al., 2016).

According to the National Council of Teachers of Mathematics (NCTM) in (Prafianti, 2019), mathematical disposition is an appreciation and tendency to think optimistically in mathematics. This opinion is in accordance with what was expressed by Kilpatrick in (Hamidah & Prabawati, 2019), mathematical disposition is a creative attitude or habit of seeing mathematics as a rational, practical, and useful object. From the definition above, a mathematical disposition can be interpreted as a behavior, desire, ambition, concern, dedication, and inclination to reason and behave positively about mathematics that originates from within. Individuals with a strong mathematical disposition will have confidence, curiosity, interest, relevance, and enthusiasm to do or understand mathematics. It is hoped that students will be able to solve problems, create useful and constructive work activities in mathematics, and be responsible in learning mathematics.

According to NCTM in (Widyasari et al., 2016) suggests that there are several indicators of mathematical disposition, namely: (1) confidence in using and solving mathematical problems; (2) flexible in solving math problems; (3) diligent and persistent in solving math problems; (4) have an interest and curiosity about mathematics; (5) perform self-reflection and self-monitoring; (6) appreciating the application of mathematics in other disciplines and real life; and (7) appreciating mathematics as a tool, language, values and culture.

Success in learning mathematics is correlated with mathematical disposition. To deal with various mathematical problems and give maximum effort in mathematics, students need a mathematical mindset (Agustianti, 2021). Mathematical disposition has contributed to the low ability of students' mathematical literacy (Dewi, 2016). Dewi revealed that individual’s mathematical literacy ability were influenced by their attitude towards mathematics. The research shows that CIRC learning with SPUR nuances is thought to be able to increase students' mathematical literacy. Students will have a good perception of mathematics because the disposition of mathematics is their positive attitude towards the subject. As a result, they will show high levels of curiosity and drive and will value mathematics more in learning activities. Thus the competence of mathematical literacy can increase. Based on the explanation of the problems above, the researcher was motivated to conduct a research entitled "Analysis of Mathematical Literacy Ability in Solving PISA-type Questions viewed from Students' Mathematical Disposition".

B. RESEARCH METHODS

The type of this research is a qualitative descriptive research. Qualitative research is research that aims to describe the reality that occurs in research subjects (Kusniati, 2018). A qualitative approach is used so that the research objectives can be limited so that the data collected can be explored further.

The subjects of this research were 10th grade MIPA 2 students at SMA Negeri 3 Kabupaten Tangerang, even semester of 2022/2023 academic year, totaling 39 students. There are several criteria for the subject of this research, namely students are at least 15 years old, students have never fail in class, and students are able to communicate their ideas orally and in writing. Data were collected through a questionnaire that measures students' mathematical disposition, a written essay test that measures students' mathematical literacy, and direct interviews. Before the research began, questionnaires and written test questions were tested for validity and reliability by lecturers and teachers of related subjects. The questionnaire contains 31 statement items with a four-answer Likert scale and is used to measure students' mathematical disposition abilities. Six essay questions on Change and Relationship are included in the written exam to measure students' ability in

mathematical literacy. Furthermore, interview data collection was carried out after students were grouped based on the level of their mathematical disposition.

In this research, qualitative descriptive analysis is a method of data analysis. In qualitative research, data is collected from several sources through several different collection techniques (Sugiyono, 2017). Data analysis was carried out after all the required data was collected. The basis of qualitative research is a series of detailed descriptions that are organized in a thorough and structured manner. Qualitative research aims to find out the facts about the abilities possessed by research subjects (Ibrahim, 2015). Data analysis activities are carried out through the following stages.

1. Mathematical Disposition Questionnaire

The mathematical disposition questionnaire that has been filled in were analyzed by scoring each statement with details of positive statements worth 4 for the response of strongly agree, 3 for agree, 2 for disagree, and 1 for strongly disagree. For negative statements, score 4 for strongly disagree, 3 for disagree, 2 for agree, and 1 for strongly agree. The value of each statement is added up to get a questionnaire score. The final score results are obtained by calculating equation (1).

$$final\ score = \frac{obtained\ score}{maximum\ score} \times 100 \quad (1)$$

The final score that has been obtained is grouped using the formula from Arikunto in (Kafifah et al., 2018).

Table 1. Mathematical Disposition Final Score Categories

Final score interval	Category
final score $\geq M + SD$	High
$M - SD \leq$ final score $< M + SD$	Medium
final score $\leq M - SD$	Low

2. Written Test Results

The results of the written test of mathematical literacy skills were analyzed through two stages. First, a score is given to each question. The maximum score for each question is 14. The scores for mathematical literacy skills can be seen in table 2.

Table 2. Scores of Mathematical Literacy Questions

Question number	1	2	3	4	5	6	Total score
Score	14	14	14	14	14	14	84

The scores obtained are converted into the PISA Framework in order score intervals can be grouped into PISA literacy levels (Schleicher, 2019). The score conversion can be seen through the following table 3.

Table 3. Mathematical Literacy Scores in PISA

Score	**Scores in PISA**	**Level**
0-40	≥ 0	1
41-47	$\geq 357{,}8$	2
48-54	$\geq 420{,}1$	3
55-61	$\geq 482{,}7$	3
62-68	$\geq 544{,}7$	4
69-75	$\geq 607{,}0$	5
76-84	$\geq 669{,}3$	6

The indicators for each level of mathematical literacy used are based on the indicators used by PISA in 2018.

3. Results of Interview

The results of interviews with students were analyzed using the Miles and Huberman model in (Merliza, 2022) which consisted of data gathering, data presentation, and drawing conclusions.

4. Triangulation

Validity check of the data in this research uses the triangulation technique in the credibility criteria. Triangulation is an effort to ensure that the information obtained from various points of view on the research conducted is accurate (Alfansyur & Mariyani, 2020). This research uses source triangulation, which concentrates on data verified by multiple sources (Sugiyono, 2017). Written tests and interviews as measuring tools are used to compare the data that has been collected.

C. RESULT AND DISCUSSION

The results of the questionnaire were divided into three groups of mathematical dispositions, namely low, medium and high. The results obtained from the mathematical disposition questionnaire are presented in table 4 below.

Table 4. Number of Students Based on Mathematical Disposition

Category	Low	Medium	High
Number of students	7	24	8

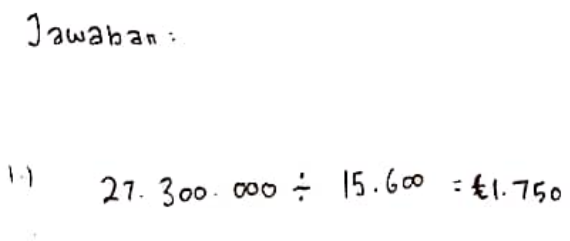
Based on the table above, out of 39 students, seven students are included in students with low mathematical dispositions, 24 students are students with medium mathematical dispositions, and eight other students are in the group of students with high mathematical dispositions. Furthermore, the selection of research subjects was carried out by means of random selection from each category. From each category one student was randomly selected, so that there were three students who were the subject of the research. The results of the mathematical disposition questionnaire for the three selected students are shown in Table 5 below.

Table 5. Results of the Research Subjects' Mathematical Disposition Questionnaire

Subjects	Questionnaire score	Final score	Category
SP-1	59	47,58	Low
SP-2	82	66,13	Medium
SP-3	109	87,90	High

After getting the research subject and the results of the questionnaire, the answers to the written test questions were checked. The written test consists of six essay questions. Each question number represents PISA difficulty or level, question number 1 is used to measure mathematical literacy ability at level 1 PISA, item number 2 measures mathematical literacy ability at level 2 PISA and so on. The questions used are PISA-type questions with Change and Relationship content. Change and relationship content is one of the four mathematical literacy contents tested in PISA, generally containing algebraic material (Teresa et al., 2020)

Based on the analysis conducted, SP-1 fulfills all indicators at level 1 and level 2.



Picture 1. SP-1's answer to question number 1

From picture 1 it can be seen that SP-1 was able to answer common questions by utilizing all the information provided. SP-1 was also able to identify questions, and able to carry out routine procedures in an effort to solve problems. This is supported by SP-1's statement in the following interview.

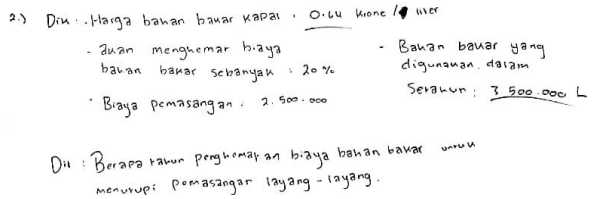
Q : OK, from question number 1, what information is known in the problem?

SP-1 : Related to how he manages his money, which was originally in rupiah, to be in euros and also the distribution of problems.

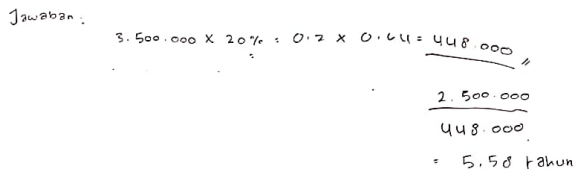
Q : Then, how did you solve question number 1?

SP-1 : So from this problem, Aldi has 27,300,000 in cash, oh yes the euros here are 15,600 rupiah. So, the euro money that Aldi earned was obtained by dividing 27,300,000 by 15,600, so the result is 1,750 euros.

In question number 2, SP-1 was able to do it correctly but did not fulfill all the existing indicators. Further interviews were conducted to find out whether SP-1 met these indicators or not. The following pictures is SP-1's answer to question number 2.



Picture 2. SP-1's answer to question number 2



Picture 3. SP-1's answer to question number 2

SP-1 was able to interpret the information and questions presented properly and is able to select relevant information to solve the problem. Even though the written algorithm looks unsystematic, SP-1 was able to explain it in the following interview snippet.

Q : OK, what information is available on question number 2 and what are the reasons for using that information in solving the problem?

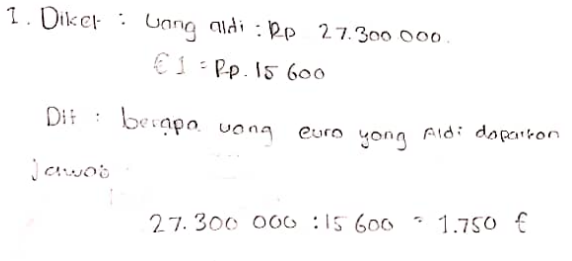
SP-1: So in number 2 there is a fuel price of 0.64 krone per liter, then he wants to save costs by 20%, then there is an installation fee of 2,500,000. There's another fuel used in a year that's 3,500,000.

Q : Then why did you use that method to answer the question?

SP-1 : Well, because those who asked how many years it takes to cover the cost of installing the kite, so the fuel used this year is multiplied by 20%, which is 0.2, then multiplied by the price of the ship's fuel, it is 0.64 per liter. So, 3,500,000 times 20% equals 0.2 times 0.64 so that's 448,000. Then 2,500,000 divided by 448,000 equals 5.58 years. So the total, uh, time to cover the cost of installing the kite is 5.58 years.

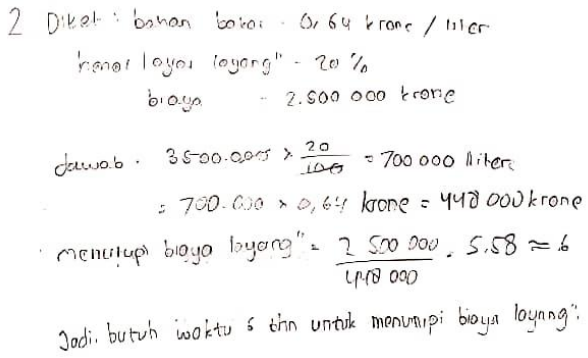
SP-1 was also able to make literal descriptions of his work orally. That way SP-1 fulfills all indicators at level 2. As for question number 5, from the interview SP-1 does not appear to be contemplating the results of his work. SP-1's answer to question number 5 did not use a model for complex situations, was wrong in choosing a strategy and did not work strategically which caused SP-1 to get the wrong answer. SP-1 did not meet all the indicators in level 3, 4 and 6 questions because SP-1 was unable to answer these questions. Students with low mathematical disposition abilities tend to be afraid of being wrong, dare not to express opinions, and don't try to work on the problems given (Machmud et al., 2022). Based on the interview, students with poor mathematical dispositions believe that their grades will remain low despite their efforts and are reluctant to voice their opinions because of the modest success they have thus far achieved, causing lack of enthusiasm and lack of confidence in their mathematical abilities. Based on this explanation, SP-1 was only able to fulfill all the indicators on level 1 and 2 questions. So that SP-1 reached levels 1 and 2 on PISA, this means that SP-1's mathematical literacy level is at level 2.

Based on the analysis conducted, SP-2 meets all indicators of mathematical literacy level 1 to level 4. SP-2 has succeeded in fulfilling all level 1 indicators, starting from answering questions in frequently encountered contexts, recognizing information and carrying out routine procedures, to always acting clearly according to stimuli.


1. Diket : Uang aldi : Rp 27.300.000
€1 = Rp. 15 600
Dit : berapa uang euro yang Aldi dapatkan
Jawab :
27.300 000 : 15 600 = 1.750 €

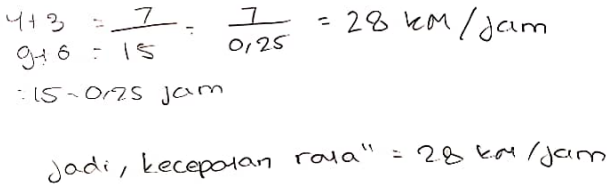
Picture 4. SP-2's answer to question number 1

In problem number 2, SP-2 was able to identify situations that require quick decision making, was able to use the right data found in the question sentence, is able to use simple algorithms to solve problems, and is able to describe the results of their work clearly.


2 Diket : bahan bakar = 0,64 krone / liter
biaya layar layang" = 20 %
biaya = 2.500 000 krone
dijawab : 35 00.000 × 20/100 = 700 000 liter
= 700.000 × 0,64 krone = 448 000 krone
menutupi biaya layang" = 2 500 000 / 448 000 ≈ 5,58 ≈ 6
Jadi, butuh waktu 6 thn untuk menutupi biaya layang".

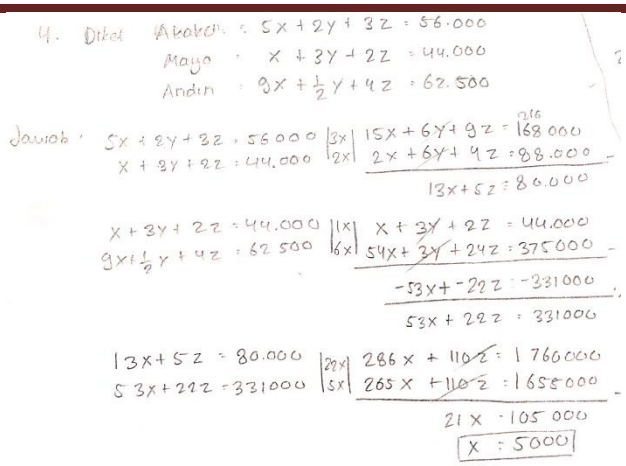
Picture 5. SP-2's answer to question number 2

SP-2 was able to answer the questions correctly. The method or procedure used is appropriate according to the decision sequence. The model used is quite simple, easy to understand and appropriate for solving the given problem. SP-2 can interpret, use, and directly create representations based on different sources, as well as use fractional and decimal representations. The solutions presented already show that SP-2 performs fundamental reasoning and interpretation. This can be seen through SP-2's answer in picture 6.

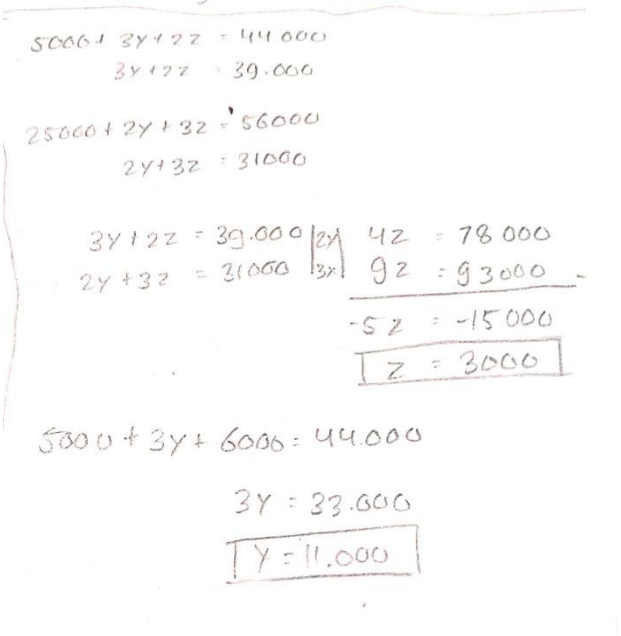

Yang 3 = 7/15 = 7/0,25 = 28 KM/jam
yang 6 = 15
= 15 - 0,25 jam
Jadi, kecepatan rata" = 28 KM/jam

Picture 6. SP-2's answer to question number 3

Problem number 4 was designed to determine level 4 literacy skills. In the context of real world questions, SP-2 successfully operate the complex models that they made, neatly and efficiently. SP-2 can select and combine many representations, including symbolic representations, and relate them to the actual situation. This can be seen from the example of an object being a mathematical variable which can be seen in Picture 7 and 8 below.



Picture 7. SP-2's answer to question number 4



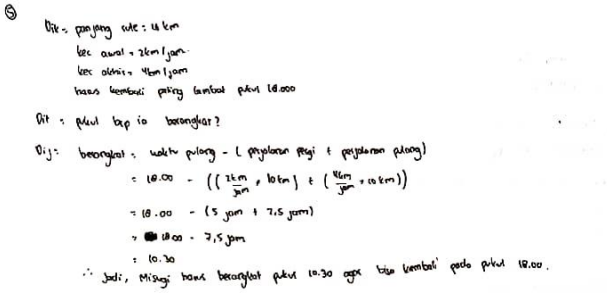
Picture 8. SP-2's answer to question number 4

Q : OK. What information was found in question number 4?
SP-2 : Ehh, there are three women who buy sugar, avocado, and jelly at the same shop. So this can be made of three equations.
Q : So how do you answer it?
SP-2 : Use the method of elimination and substitution.
Q : What are the elimination and substitution?
SP-2 : I use the example of x as avocado, y as sugar and z as jelly. Then the first equation here is for Mrs. Akako, the second equation is Mrs. Mayo and the third equation is Mrs. Andin. I eliminated y using equations 1 and 2 to get equation 4, then equations 2 and 3 to get equation 5. Then, equations 4 and 5 eliminated the z to get x. Once the x is known, it is substituted into equations 1 and 2 to produce equations 6 and 7. Equations 6 and 7 eliminate the y and get the z value. Finally, substitute x and z into equation 1 to get y. So the price of avocado is 5,000, sugar is 11,000 and jelly is 3,000.

From the interviews it can be seen that SP-2 is able to take advantage of its limitations in a direct context, this can be seen from SP-2 who immediately chose to use the substitution elimination method to solve the problem. SP-2 is also able to communicate reasons and ideas well and logically. SP-2 failed to fulfill the indicators at levels 5 and 6 because they didn't know how to answer the questions. SP-2 failed to establish assumptions as well as identify issues. The assumptions that SP-2 made were very different from what was stated in the problem. The mathematical model created by SP-2 was incorrect as a result of this important factor. This results in a settlement approach that SP-2 shouldn't apply. SP-2's literacy skills are quite good, being able to solve common problems encountered at the high school level. Students with medium

mathematical literacy skills are able to formulate and explain what is being asked and model it in mathematical form (Jannah et al., 2022). Although the end outcomes do not contain the correct results, SP-2 dares to solve problems, offer opinions, and is unafraid of being incorrect. They are quite self-assured, dare to try, but lack strong mathematics literacy, and they also wish to learn from their failures. The ability of students in this category is quite good, but can be improved again to achieve higher literacy skills. Based on the explanation above, SP-2's mathematical literacy skills are at level 4 PISA.

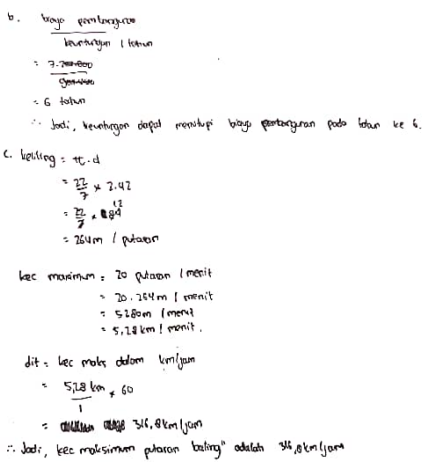
Based on the analysis that has been done, SP-3 meets all indicators of mathematical literacy from level 1 to level 6. SP-3 successfully handled questions number 1-4 well, the same was the case with SP-2. The big difference between the two students was that SP-3 was able to work on and complete questions number 5 and 6 correctly. SP-3's answer to question number 5 can be seen in picture 9 below.



Picture 9. SP-3's answer to question number 5

Based on the answers, SP-3 seems to be able to identify information, determine assumptions and develop models very well. The selected strategy has been well evaluated for solving complex problems and the displayed work results show strategic work. In addition, SP-3 has also contemplated the work and is able to formulate and communicate interpretations and reasons.

In problem number 6, SP-3 was able to develop concepts, generalize, and utilize information obtained through investigations in complex situations. SP-3 succeeded in connecting sources of information and representation, and running between them efficiently, as well as applying knowledge and understanding along with mastery of symbolic and formal mathematical operations and their relationships, to create new strategies and techniques in dealing with current situations. SP-3's answers can be seen in picture 10.



Picture 10. SP-3's answer to question number 5

SP-3 has above average knowledge, even SP-3 is able to think and reason highly, is able to reflect on one's own actions, and is able to formulate and communicate reasons, opinions, as well as images found well. This is also corroborated by the following interview excerpts.

Q : All right, how do you answer number 6?
SP-3: Development costs divided by profits per year.
Q : So the result?
SP-3: It should be 8 years but I miscalculated.
Q : OK, why are the development costs divided by the profit per year?

SP-3: It's known that the profit formula is 900,000t – construction costs, and the construction costs above that are 7,200,000. So the formula becomes P = 900,000t – 7,200,000. In order for the profit to cover construction costs, P must be 0. So 7,200,000 = 900,000t, then t equals 7,200,000 divided by 900,000, the result is 8 years.

P : Okay, but you wrote this wrong.

SP-3: Yeah.

Q : Okay, what about the next one?

SP-3: So what was asked is the maximum speed of the propeller rotation, if I initially looked for the circumference first, the circumference is phi times d, the circumference is 264 meters per rotation. Then the maximum speed is that the propeller rotates 20 revolutions per minute, 20 revolutions means 20 times 264 meters, which means around 5,280 meters per minute, or 5.28 km/minute. Those who are asked about the maximum speed in km/hour means staying at times 60. The result is 316.8 km/hour.

Q : Why are you looking the circumference?

SP-3: Because the rotating propeller is in the shape of a circle, so the rotating propeller is the same as the circumference of the circle.

Based on the explanation above, students with high mathematical dispositions (SP-3) can fulfill all indicators at levels 1 to 6, so SP-3 literacy skills are set at level 6 or the highest level. SP-3 has almost no difficulty in answering questions, even SP-3's written test score is almost perfect if there are no writing errors in question number 6. Students with high literacy are able to fulfill three aspects of literacy, namely formulating, using, and interpreting (Aningsih, 2018). This is also supported by (Farida et al., 2021) which states that students with high literacy skills have good mathematical literacy skills and are able to interpret mathematics into real-world contexts. According to the answers and the outcomes of the interview, SP-3 has a high level of confidence in mathematics, the courage to express and articulate their thoughts clearly, and they do not fear being found incorrect. This is based on SP-3, a student who does well in school, is involved in extracurricular activities, and has become used to asking and responding to questions in class. SP-3 acknowledged that they was accustomed to solving math literacy problems.

The results of the research indicate that a student's mathematical disposition and their level of mathematical literacy are directly correlated. Low mathematical disposition students can only complete problems that require several steps to complete, and they are unable to complete questions at levels 3-6 because they do not comprehend the questions' objectives or how they should answer them. Due to a lack of problem comprehension, students with low math literacy abilities frequently struggle to solve problems and recognize questions (Fahlevi & Zanthy, 2020). Students with a moderate mathematical dispositions were able to answer simple and complex questions, but they struggled to answer problems requiring a high level of mathematical literacy. This is due to their inability to think and reason clearly, which causes them to frequently fail when detecting problems or making assumptions about questions, as well as while creating models and managing computation sequences. Students with average mathematical disposition frequently make errors in arithmetic operations, which leads to incorrect answers (Jannah et al., 2022). students with a high mathematical disposition are able to perform high-level reasoning, solve all problems in a coherent manner, and are able to relate and use their knowledge in other subjects to solve mathematical literacy problems. They have no problem formulating and transforming real-world problems into mathematical forms and vice versa, because they are accustomed to facing literacy-related math problems. Students with high abilities are able to formulate, apply and interpret mathematical results into real-world contexts (Farida et al., 2021).

The explanation above is in accordance with the learning theory of behaviorism which emphasizes changes in behavior as a result of experience (Amsari & Mudjiran, 2018). This is in accordance with what was stated by one of the originators of behaviorism learning theory, namely Edward Thorndike, who said that learning is an event of the formation of associations between events called stimulus and response. In this study, students with low mathematical dispositions never encountered or were given mathematical literacy questions (stimulus), resulting in low levels of mathematical literacy (response). Students with moderate dispositions rarely solve math literacy questions, so the results obtained are quite average. Whereas students with a high mathematical disposition who often train themselves with math problems often encounter math literacy questions so that the response given is quite good, as evidenced by their success in answering all the questions without any significant problems.

D. CONCLUSION AND SUGGESTIONS

Based on the analysis and discussion presented, the results showed that seven students were included in the category of low mathematical dispositions, 24 students had medium mathematical dispositions, and eight students had high mathematical dispositions. On the PISA mathematical literacy scale, low mathematical dispositions students get level 2, medium mathematical dispositions students reach level 4 while strong mathematical dispositions students attained level 6.

Students are advised to try to understand and start loving mathematics. Students need to grow their own mathematical disposition so that learning achievement in mathematics becomes better. Likewise with the ability of mathematical literacy. Students are expected to have more motivation and practice working on various types of mathematical literacy questions. For teachers, teachers can use the results of this research to evaluate learning activities that have taken place. Teachers are expected to start giving math literacy practice questions in order to develop students' mathematical literacy skills.

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