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Analysis of High School Students' Mathematical Literacy Skills in Solving Contextual Problems on SPtDV Material

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Abstract

Mathematical literacy is one of the abilities that must be possessed in today's 21st-century education. This study aims to describe the mathematical literacy skills of grade X students at one of the Yogyakarta high schools in Bantul Regency in solving contextual problems on SPtDV (System of Inequality of Two Variables) material. The method used was descriptive qualitative. Data were collected through multiple-choice tests, descriptions, and questionnaires using SPtDV material. Data analysis was done by reducing and presenting data, and drawing conclusions based on indicators of students' mathematical literacy (mathematical process). Sampling of the population was carried out using a non-purposive sampling technique. To determine the number of samples to be taken, researchers used a saturated sampling technique. The research subjects were students of class X of Yogyakarta Private Senior High School in Bantul Regency in the first semester of the 2023/2024 academic year, with a total of 20 students. The results showed that students with high ability were able to fulfill all three aspects of the indicators in mathematical literacy skills, namely formulating, using, and interpreting. While students with moderate ability were able to fulfill two aspects of the indicator, namely formulating and using. And students with low ability were only able to fulfill one aspect of the indicator, namely formulating. The percentage of results obtained is based on the Mathematical Literacy Profile Criteria, namely: 10% proficient, 60% proficient, 15% basic, and 15% need special intervention. This study implies that it is important for other researchers to explore the factors that influence the mathematical literacy skills of low-ability students, especially in high school students or equivalent.

Keywords: *Contextual; Mathematical literacy; SPtDV*

Introduction

Over time, the education sector in Indonesia has evolved to meet the needs of the skills required to create the desired graduates. The World Economic Forum in 2015 conducted meta-analysis research on the 21st-century skills that students should have. The 21st-century skills that must be possessed are basic literacy, basic competence, and character quality. Basic literacy is in the form of reading and writing literacy, mathematical literacy, scientific literacy, ICT literacy, financial literacy, and cultural and civic literacy. (World Economic Forum, 2015).

The orientation of education today is for students to acquire the skills needed to meet the needs of today's society. (Suryapuspitarini et al., 2018). One of them that we often find in everyday life is

problems related to mathematics. Mathematical literacy skills are needed so that they can use their minds to solve and solve problems in everyday life and are better prepared to face the challenges of future life. (D. I. Lestari et al., 2020; Stacey & Turner, 2015).

It is important to develop these skills through subjects, especially mathematics. Students' ability in mathematics is not only limited to numeracy but also involves the ability to think logically and critically in solving everyday problems. This mathematical ability is referred to as mathematical literacy (Sari, 2015). In addition, the National Council of Teachers of Mathematics (NCTM) states that students who learn mathematics should have the ability to understand, solve problems, connect mathematical concepts, and represent mathematical ideas. The ability to represent mathematically can enrich students' mathematical knowledge, because it can be used to solve everyday problems. (Atsnan et al., 2018).

Mathematical literacy, as described in the PISA report, refers to an individual's ability to formulate, apply, and interpret mathematical concepts in a variety of situations. (OECD, 2019). It involves the ability to use mathematical reasoning and mathematical concepts, as well as mathematical procedures, facts, and functions to describe, explain, and predict phenomena. Previously, the term mathematical literacy was introduced by the NCTM (National Council of Teachers Mathematics), which identified five key competencies in mathematics learning: mathematical problem solving, mathematical communication, mathematical reasoning, mathematical connections, and mathematical representation. (Maulyda, 2019). Mathematical literacy includes the ability to master these five competencies.

Mastery of mathematical literacy enables individuals to reflect on mathematical logic and play an active role in life, community, and society in general. (Ulya & Wardono, 2019). Mathematical literacy is considered as important as reading and writing skills (Abdussakir, 2018). (Abdussakir, 2018). It provides individuals with the ability to engage in mathematical literacy, which involves estimating and interpreting information, problem-solving, reasoning, and communication using the language of mathematics. Reading in a mathematical context involves understanding mathematical language, such as symbols, algebraic equations, diagrams, and graphs. (Lubis & Rahayu, 2023). Writing in the context of mathematics focuses on mathematical communication skills in writing to convey mathematical understanding as a result of reading, interpreting, and understanding real situations in mathematical language. (Larasaty & Pratini, 2018).

Another opinion states that mathematical literacy includes a person's ability to formulate, use, and interpret mathematical concepts efficiently in various contexts of everyday life. (Madyaratri, 2020). This includes all mathematical concepts, procedures, facts, and tools in terms of calculation, numbers, and space. (Muslimah & Pujiastuti, 2021). More than just the ability to calculate, mathematical literacy also involves the ability to communicate, think logically, and other mathematical thinking processes, which as a whole is known as the mathematization process. (Sari, 2015).

Mathematics education is one of the important aspects of shaping students' intellectual abilities. (Sulistiani & Masrukan, 2016). Mastery of mathematical literacy is not only limited to mastering basic concepts but also involves students' ability to apply these concepts in contextual situations. (Maryani & Widjajanti, 2020). One of the challenging materials in learning mathematics is SPtDV (System of Inequalities of Two Variables). (N. P. Lestari & Aziz, 2022). In this context, it is important to analyze students' mathematical literacy skills in solving contextual problems on SPtDV material. A deep understanding of students' mathematical literacy skills can provide an overview of the extent to which students can apply mathematical concepts in real-world contexts. (Masjaya & Wardono, 2018). Therefore, this study aims to explore and analyze the extent to which students can overcome the challenges that arise in solving contextual problems on SPtDV material.

Through this analysis, it is hoped that an effective learning strategy can be found to improve students' mathematical literacy in the context of SPtDV material. This improvement will not only enrich

students' mathematical knowledge but also equip them with skills that can be applied to solving everyday problems.

This research is also relevant to the times when literacy in mathematics is a highly valued skill in various fields of work. (Rusmana, 2019). Therefore, understanding the extent of students' mathematical literacy in solving contextual problems in SPtDV material can make a positive contribution to creating a generation that excels in aspects of mathematical skills and problem-solving. With this background, this study describes in depth the analysis of students' mathematical literacy skills in solving contextual problems on SPTDV material, with the hope that it can make a positive contribution to the development of more effective and applicable mathematics learning methods.

Research Methods

This research method uses a descriptive method that produces data in the form of written or spoken words from people or observed behavior. (Moleong, 2016). The approach used is qualitative, which does not focus on statistics, but rather on qualitative evidence. This research uses a qualitative approach to describe the problems and research focus. Qualitative methods are social research steps that aim to obtain descriptive data in the form of words and images. The type of research used is descriptive using a qualitative approach.

Sampling of the population was carried out using a non-purposive sampling technique. According to Sugiyono (2017), non-probability sampling is a sampling technique that does not provide equal opportunities or opportunities for each element or member of the population to be selected as a sample. To determine the number of samples to be taken, researchers used saturated sampling techniques. Sugiyono (2017) explains that saturated sampling is a sampling technique in which all members of the population are used as samples in the study. The research subjects were class X students of Yogyakarta Private High Schools in Bantul Regency in the first semester of the 2023/2024 academic year, with a total of 20 students. The selection of subjects used a non-purposive sampling technique, where several students were selected as subjects with high, medium, and low mathematical literacy abilities respectively. High-ability students can perform all three mathematical literacy processes, while medium-ability students can perform two mathematical literacy processes, and low-ability students can only perform one mathematical literacy process, respectively.

The research instrument involved a test of contextual questions on SPtDV material, which was given to students, as well as a questionnaire as a means of understanding students' mathematical literacy skills. The results of student work and questionnaire data were used as the basis for analysis with the stages of data reduction, data presentation, and conclusion drawing. The questionnaires were given using guidelines to ensure consistency between researchers and subjects so that the data obtained could be considered valid. The following is the lattice of the Mathematical Literacy Instrument.

Table 1. Lattice of Mathematical Literacy Instruments

No.	Indicator	Item number	Number of items
1	*Formulate* (formulate real problems systematically*)*	1, Essay 1	2
2	*Employ* (Using math in concepts, facts, procedures,and *reasoning)*	3.5, Essay 2	3
3	*Interpret* (Interpret the solution of a *mathematical* process*)*	2, 4, Essay 3	3
	Total question items		8

The mathematical literacy test will be scored using a modified mathematical literacy score. From Linuhung 2014 as the table below.

1. **Multiple Choice**

Score 1 if the answer is correct Score 0 if the answer is wrong

2. Essay

Table 2. Scoring Guidelines for Mathematical Literacy Skills

Indicator	Scoring Criteria	Score
Ability to formulate real problems systematically (*formulate*)	The answer is correct and uses the formula an appropriate and complete way of solving	4
	The answer is correct but does not write a formula and solution method completely	3
	The answer to the question given is less precise but writes the formula and the solution completely.	2
	Answers to questions given less precise and not wrote down the solution	1
	Did not answer the question given	0
Ability to use math in concepts, Facts, procedure, and reasoning (*employ*)	The answer is correct and uses the formula an appropriate and complete way of solving	4
	The answer is correct but does not write formula and solution method completely	3
	The answer to the question given is less precise but writes the formula and the solution completely.	2
	Answers to questions given less precise and not wrote down the solution	1
	Did not answer the question given	0
Ability to interpret solution of process math (*interpretation*)	The answer is correct and uses the formula an appropriate and complete way of solving	4
	The answer is correct but does not write formula and solution method completely	3
	The answer to the question given is less precise but writes the formula and the solution completely.	2
	Answers to questions given less precise and not wrote down the solution	1
	Did not answer the question given	0

(Modified from Linuhung (2014))

Scoring guidelines are categorized into three categories, namely high ability, namely scores 4 and 3, medium ability, namely score 2 and low ability, namely scores 1 and 0.

The student's completeness value is seen with the KKM set by SMA Swasta Yogyakarta, as follows:

Table 3. KKM of Yogyakarta High School

No	Predicate Interval	Predicate
	92 - 100	A
	83 - 91	B
	75 - 82	C
	< 75	D

Where the grades with predicates A, B, and C obtained by students are included in the complete category and those with predicate D are included in the incomplete category.

Results and Discussion

The importance of understanding mathematical literacy is a very important part of improving students' mathematical abilities. This has led to an in-depth analysis of the answers to mathematical literacy questions. In this exploration, the structure and types of questions asked in mathematical literacy examinations will be discussed, to gain a better understanding of the extent to which students can apply mathematical knowledge in real-life situations. This discussion will not only identify potential difficulties that students may face but will also provide a sharper view to strengthen relevant learning strategies. By breaking down the mathematical literacy items, we can identify specific aspects that require more attention, guiding us toward effective teaching approaches that meet the developmental needs of students' mathematical skills.

Based on the student mathematical literacy test which was Table 4. Student summative score results were grouped based on students' mathematical ability, the results were obtained as shown in Table 4 below.

Table 4. Student summative score results

Code name	Gender	Value	Predicate	Kode name	Gender	Value	Predicate
AH	Men	65	D	IG	Men	33	D
FC	Women	83	B	IM	Women	75	C
II	Men	59	D	VS	Women	62	D
BK	Women	76	C	AY	Men	74	C
CK	Men	83	B	GK	Women	83	B
NG	Men	30	D	KA	Women	70	D
RT	Men	71	D	KD	Men	44	D
YO	Women	94	A	LU	Women	90	B
GK	Women	77	C	VM	Women	80	C
HI	Men	82	C	YP	Men	76	C

From the results of the assessment carried out based on the scoring guidelines for mathematical literacy skills regarding the KKM set by the school, a diagram of student completeness is obtained as shown in Figure 1 below:

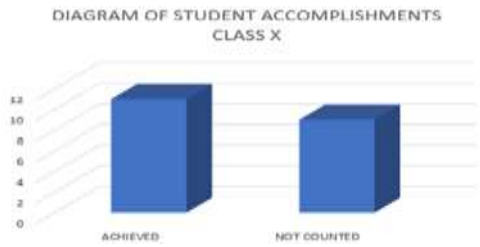


Figure 1. Diagram of Student Completion in Class X

After scoring, researchers conduct item analysis which is used to assist in evaluating the quality of exam questions. If a question has the right level of difficulty, which is not too easy or too difficult, and has good differentiation, it means that the question can provide better information about the level of skill or knowledge of the participants. The following analysis results are shown in Table 5 below:

Table 5. Analysis of Distinguishing Power and Question Level of Difficulty

Item No.	Distinguishing Power		Difficulty Level		Conclusion
	Coefficient	Description	Coefficient	Description	
1	0.69	Good	0.82	Easy	Good enough
2	0.61	Good	0.82	Easy	Good enough
3	0.78	Good	0.64	Medium	Good
4	0.75	Good	0.64	Medium	Good
5	0.78	Good	0.82	Easy	Good enough
Essay 1	0.55	Good	0.50	Medium	Good
Essay 2	0.57	Good	0.30	Medium	Good
Essay 3	0.84	Good	0.60	Medium	Good

It was concluded that the questions tested were feasible with good enough categories. From the results of the scores obtained by students, researchers are also seen based on the Profile Criteria for Mathematical Literacy Skills in Table 6, and the results in percentage are depicted in Figure 2 below:

Table 6: Criteria for Mathematical Literacy Profile

Interval for Score Acquisition	Mathematical Literacy Profile	Many Students
0%-45%	Needs special intervention	3
46%-65%	Basic	3
66%-85%	Competent	12
86%-100%	Proficient	2

(Modified from Ministry of Education and Culture, 2021)

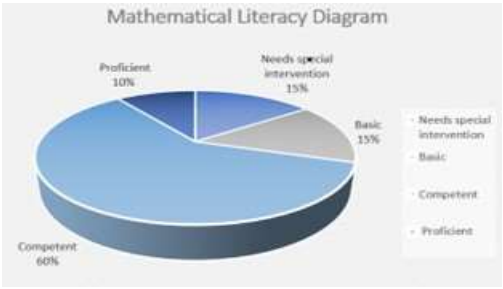


Figure 2. Diagram of Mathematical Literacy

The next analysis was conducted per indicator per item and mathematical literacy indicator. This analysis will provide a more detailed view of students' strengths and weaknesses in dealing with mathematical challenges. Through this table, we can detail the contribution of each indicator to the overall achievement, guiding us to devise learning strategies that are more focused and responsive to students' individual need.

Table 7. Achievement per indicator perquestion item

Question No.	1	2	3	4	5	6	7	8
Many Scores	12	12	10	13	12	41	43	34
Percentage %	60	60	50	65	60	51	54	43

The achievement per indicator per item shows that the average of each question can be answered by more than 55% per item. So it can be concluded that students' mathematical literacy skills are good. The existing questions then analyzed the achievement per mathematical literacy indicator shown in Table 8.

Table 8. Achievement per Math Literacy indicator

Indicator	Manyscores	Percentage
Formulate (formulate real problemssystematically)	44	60%
Employ (Using math in concepts, facts,procedures, and reasoning)	50	72 %
Interpret (Interpret the solution of a *mathematical* process)	44	60 %

Analysis of Student Mathematical Literacy Questions

1. Formulate

Problem!

A person's ideal weight depends on their height. A person is said to havean ideal weight if they have the following two conditions:

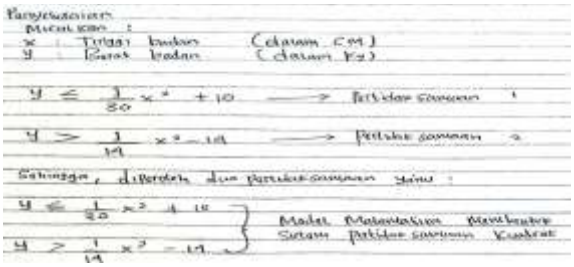
a. If the weight (y in kg) of theperson is less than or equal to 1/30 times the square of the height (x in cm) of the person plus 10
b. If the person's weight (y in kg) ismore than 1/14 times the square of the person's height minus 14.

Make a mathematical model of the problem above!

a. Subject AY's answer score is 4

AYW subject has successfully described the given problem accurately through mathematical modeling. AYW subject used inequality signs appropriately, according to the context of the problem at hand.

Figure 3. Formulate Subject AY score 4



b. KD subject answer score 2

Subject KD has shown his ability to interpret and model problems concretely into mathematical representations with the use of inequality signs and the intended coefficient values are written correctly. However, there were some obstacles in transforming the problem into algebraic form. One of them was the presence of the variable y in the equation, whereas the variable y should have been replaced with the variable b. In addition, the b variable written in the equation is the a variable. This needs to be corrected to fit the context of the problem at hand.

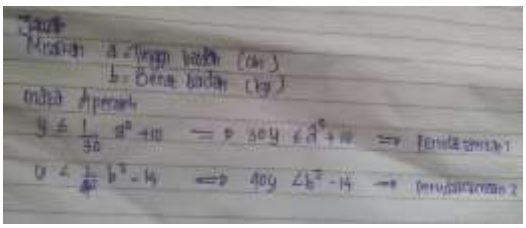


Figure 4. Formulate KD subject score 2

c. YO subject answer score 1

YO subjects have shown the ability to transform the problem into algebraic form, but it seems that there are still obstacles in their ability to interpret and model the problem concretely into mathematical representations that fit the desired context.

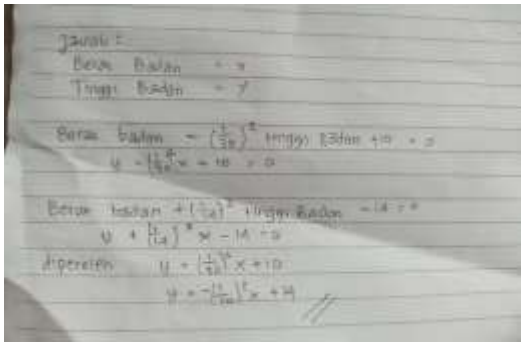


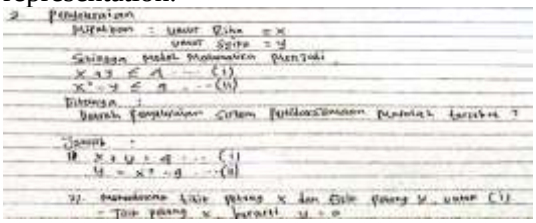
Figure 5. Formulate Subject YO score 1

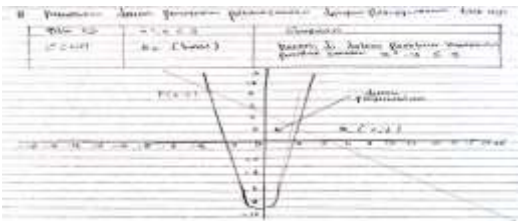
2. Employ
Problem!

The sum of the ages of Rina and Syifa in 1997 is at most 4. The difference of the squares of Rina's age and Syifa's age in that year is at most 9. What are the possible ages of Rina and Syifa in that year (if both their ages are integers)? Draw the solution area.

a. Subject GK's answer score 4

Subject GK has shown satisfactory ability in modeling the given problem accurately, and was able to correctly draw the graph according to the predetermined procedure. Proficiency in responding to graph requests not only includes accuracy in the application of specified procedures but also reflects a good understanding of the mathematical content at hand, creating an appropriate and informative visual representation.





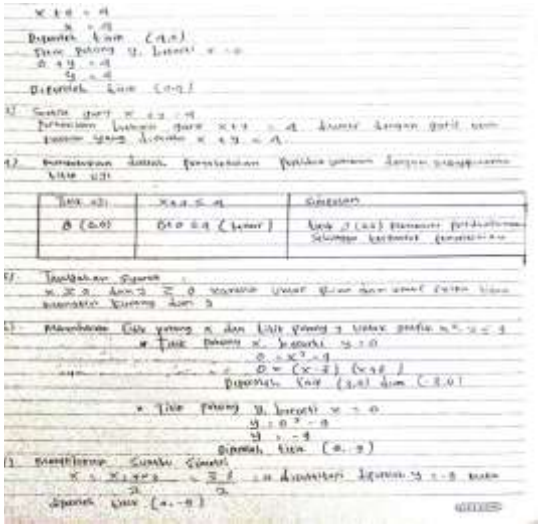


Figure 6. Employ Subject GK score 4

b. NG subject's answer score 2

Subject NG has shown significant ability in modeling problems in the form of mathematical equations. However, some obstacles still need to be overcome, especially in determining the intersection points that still show discrepancies. In addition, it should be noted that there are inaccuracies in determining the desired graph completion area. Therefore, additional steps in improving the clarity and accuracy in determining these parameters can be a constructive step toward a deeper understanding of mathematics.

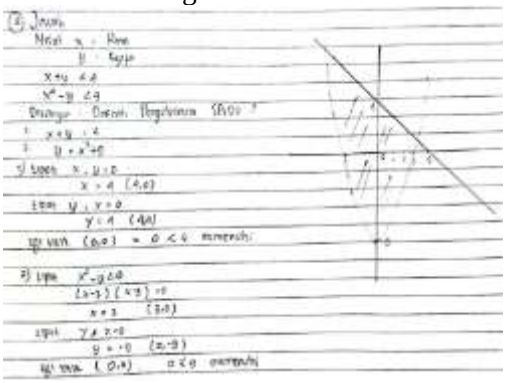


Figure 7. NG Subject's Employ score 2

a. IG subject's answer score 1

Subject IG has not shown significant ability in modeling problems into the form of mathematical equations. This can be seen from the mistakes made in transforming the problem into the right mathematical form, as well as in substituting one variable for another. As a result, the desired solution is not as expected.

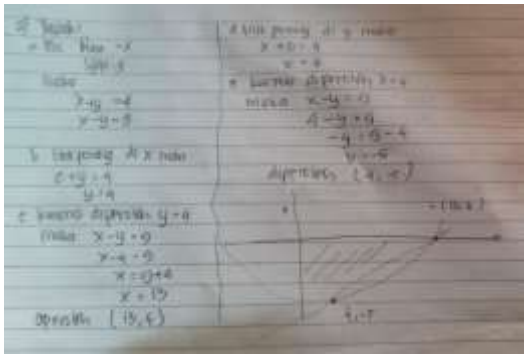


Figure 8. IG Subject's Employ score 1

b. Interpret

Problem!

Find the system of inequalities for the following solution area.

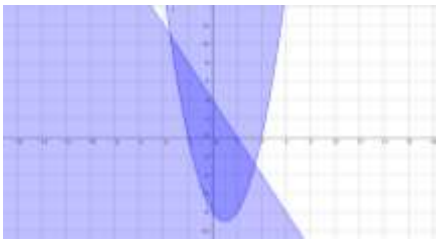


Figure 9. Problem no. 3

a. GK subject answer score 3

Subject GK has successfully solved the given problem carefully and precisely by the predetermined mathematical procedures. Although GK was able to interpret the solution of the mathematical process well, it is unfortunate that there was an omission, namely subject GK forgot to write the second inequality which should be an integral part of the mathematical solution. The importance of including every necessary element in the mathematical formulation is a crucial aspect that can improve clarity and completeness in presenting the math solution.

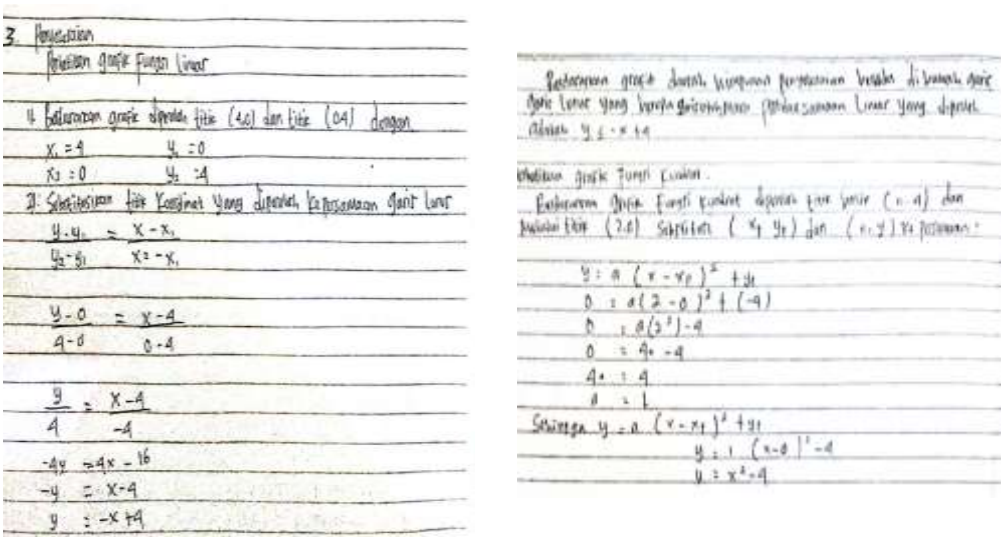


Figure 10. Subject GK's Interpretation Score 3

b. AH subject's answer score 2

Subject AH was able to determine the points on both graphs, although it is unfortunate that AH was not able to obtain the desired inequality, and some errors appeared in the solution process. It is important to note that the final result AH wrote down was inconsistent with the initial value that should have been represented, indicating the need for revision and a deeper understanding of the mathematical concepts involved in the problem. Thus, additional attention to the stages of solving and the correlation between the final result and the initial value will strengthen students' understanding of the mathematical context at hand.

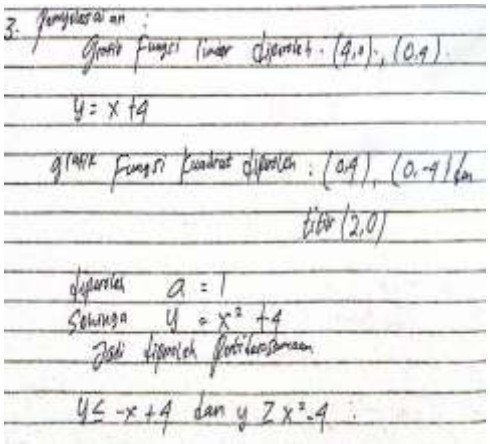


Figure 11. Interpretation of Subject AH score 2

c. YP subject answer score 1

Subject YP was only able to determine the points on both graphs, but was not able to substitute them into the formula correctly. The error occurred when entering the x and y variables, resulting in an incorrect inequality and causing errors in the overall solution.

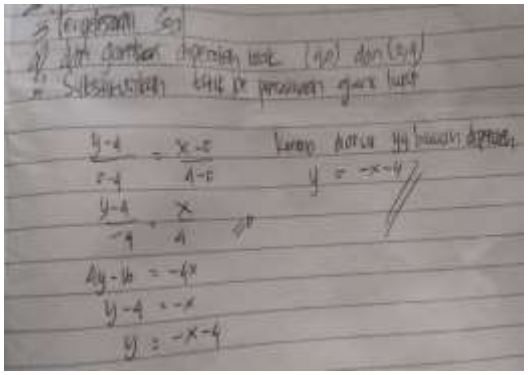


Figure 12. Interpretation of Subject YP score 1

To measure students' understanding of SPtDV, assessment is not only limited to summative exams. As a complement, the researcher provided a questionnaire to be filled in after the summative assessment session lasted for approximately 10 minutes. This questionnaire was designed to illustrate students' level of understanding of SPtDV material, providing additional insight into the extent to which concepts have been absorbed and understood by students. With this assessment, a more comprehensive picture of students' learning achievements in SPtDV-related materials is expected. The following is the percentage of the self-assessment questionnaire given to students, namely "How confident are you in your ability to solve the given problem?

Figure 13.Student confidence questionnaire

Based on the analysis of the diagram above, it can be seen that the percentage of students' confidence in working on problems, dominant in neutral, namely 35%, stands out higher than the other categories. However, it should be noted carefully that students who have not achieved full understanding and are less active in the learning process and problem-solving, namely very unsure, are in position no. 2 at 25%, this is a challenge that needs to be overcome by educators. Therefore, teachers must focus and find solutions to this problem. Responding to students' incomprehension and lack of engagement can be a top priority to improve learning effectiveness so that all students can achieve optimal understanding and be actively involved in every aspect of learning.

Conclusions and Suggestions

From the achievement of mathematical literacy presented, it is obtained that per item of mathematical literacy indicators has a good percentage in each of indicators 1, 2, and 3 of mathematical literacy. The achievement of the results per indicator per item of the eight questions the percentage obtained ranges from 43% to 65%. Likewise, the achievement per indicator of mathematical literacy obtained, namely indicators 1 and 3 is 60% and indicator 2 is 75%. The percentage of results obtained is based on the Mathematical Literacy Profile Criteria, namely: 10% proficient, 60% proficient, 15% basic, and 15% need special intervention.

Based on the analysis of mathematical literacy skills in the context of SPtDV material, further efforts are needed in developing learning strategies. Recommendations that can be proposed involve a more contextualized approach, the use of active learning methods, interactive learning media, and an emphasis on applying mathematical concepts in real contexts. In addition, increased collaboration between mathematics teachers and teachers of other subject areas can open up opportunities to integrate mathematical literacy more effectively into SPtDV learning. Thus, it is expected to improve the understanding and application of mathematical concepts in this material, creating a more thorough and integrated learning for students.

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