High school students’ mathematic literacy performance in solving linear programming problem

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Abstract. The mathematic literacy performance is the capability that is gotten by students applied on daily activities. The ability which uses logical thinking and knowledge that they got can solve the prose of learning till the subject can be used for life in 21 centuries. This research supposes to describe mathematic ability of student on grade XI IPA 1 SMA N 1 Karangdowo. This type of research is qualitatively descriptive. The research subject of 32 students which are taken using purposive sampling method. The result of research shows that mathematic literacy performance of student only reach on the third level, those are can present the resource information. The first indicator is 87.50% which the highest categorized. The second indicator is 75.78% which the higher categorized. The third indicator is 70.31% which the medium categorized. The fourth indicator is 39.06% which the low categorized. The fifth indicator is 1.56% which the lower categorized and on the sixth indicator is 0%, so that overall can be seen the average mathematic literacy performance for student grade XI IPA 1 is 45.70% with low categorized. The teacher should not push comprehension routine procedural but also variety in giving problem.

1. Introduction

Education as one learning for children in this nation wich is faced some global competitions [1]. The worst competition in this 21st century is how student can be able to implement knowledge and ability in the majored lesson to the real life [2]. Knowledge and ability that is always faced student is the mathematic literacy ability [2]. The mathematic literacy ability is one of the ability for identifying, understanding the use of mathematic in fulfill the individual necessities of life [3,4,5]. The difficulty which is the most happened to student is formulating problem to daily life because student is not use to use these ability yet [6]. It causes ability that must be understood by student will be stuck and they will face the difficulties for searching and involving their ability [7]. The grade of literacy performance for every students can be same but in representing the performance of each students has each characteristic so it needs achievement level for measure and know the student performance level [8,9]. Representing the student’ mathematic literacy performance can be easy and difficult since it needs achievement level and surfing on the student’ characteristic themselves.

The mathematic literacy performance very expected and important for supplies in this 21st century, beside that the literacy performance also help student to involve performance and the link between knowledge which has been gotten to apply on the daily life so that student will have been able
to do logical thinking and solving the complex problems in the recent life or in the future [10]. The important of teacher involving the mathematic literacy performance is as guideline to identify knowledge that has been gotten by students when they have applied on daily life using logical thinking and knowledge they got so during teaching, the teacher can correct the proses of learning so the performance that has been gotten from student will be useful on this 21st century [11]. Due to the researches for knowing mathematic literacy performance on students with conclude that student’ mathematic literacy performance is still low [10,12,13,14]. There are many research that describe mathematic literacy performance is low categorized only as the measure but there is no handling or a solutions that can be recommended. It is not shown clear yet, it is still mistake found in the achievement indicator or students are not usually in using or applying literacy performance on mathematic lesson at school.

The literacy performance that is applied inside mathematic materials at school are the problem appear to be appointed as a research since the develop performance has very tight link to the material lesson [1]. Based on data pamer 2019 at SMA N 1 Karangdowo on linear program material gets 54,15 for the averages while the district gets 62,44 for the averages, province gets 62,50 and the national gets 62,00. It is shown that the averages of linear program material at SMA N 1 Karangdowo is still lower than the averages of them. On this material of program linier at grade XI is very helpful on developing the mathematic literacy performance on the daily life [10]. The performance in forming mathematic about the real life will make students motivate on the solving so in unconscious can help involve the mathematic literacy performance [14,15,16,17]. In this topic, the student does not understanding the material only, but also they can solve the big problem in this 21st century which is about performance [16]. Beside those, the literacy performance is also becoming instruction for looking development of the literacy level and students’ knowledge so they will be easy monitored for their performance level [18].

2. Method
This study aims to determine the mathematic literacy performance of students of grade XI IPA in solving mathematical problems in linear program material. This research uses descriptive method with a qualitative approach. The research subjects taken by the researcher are the students of grade XI IPA 1 of SMA Negeri 1 Karangdowo as many as 32 students who were taken using a purposive sampling technique which is the technique of determining the sample with consideration of the research objectives [19]. The main instrument used in this study is the researcher himself where to find data and collect data directly from the source data.

The two collected data by the researcher are written test results and interview results then analyzed using triangulation methods [19,20]. Written test aims to know the mathematic literacy performance that has been validated by mathematicians while the interview to get more in-depth information about mathematic literacy performance. Written test is given in form with six questions where the assessment technique for each tested with none answer get zero score, the one unable in solving problems get one score, wrong in solving problems get two score, less precise in solving problems get three score, be able in solving problems correctly get four score. The number of each presented problem is tested differently for each indicator.

Table 1. Indicators of mathematical literacy abilities and scoring guidelines

| Indicator | Levels & Question Numbers |
|-----------|---------------------------|
| Identifying the information and solving the procedures of routine base on the instruction directly at the explicit situations. | 1 |
| Applying the basic algorithms, formulating, using, implement the procedures or basic determinates. | 2 |
| Interpreting and representing the different resources information and state the reasons directly from obtained material. | 3 |
| Combining the different representations and develop skills with the real situations that are flexible according to context. | 4 |
Evaluating problem solving strategies using wide logical thinking and combining knowledge and skills of mathematic with the real situations.  
Doing the conceptual, generalization and using information base on investigation and modeling on the complex problem situations.

3. Result and Discussion

3.1. Result

Based on data from written tests taken by researchers to measure the mathematical literacy abilities of students the researchers present in detail the achievement of the indicators for each item in the indicators.

Table 2. Achievement results for each item on the indicators of mathematical literacy abilities

| The Indicators of Mathematical Literacy Ability                                                                 | Levels & No Questions | Total Score Obtained | Percentage |
|----------------------------------------------------------------------------------------------------------------|------------------------|----------------------|------------|
| Identifying the information and solving the procedures of routine base on the instruction directly at the explicit situations. | 1                      | 112                  | 87.50%     |
| Applying the basic algorithms, formulating, using, implementing the procedures or basic determinates.           | 2                      | 97                   | 75.78%     |
| Interpreting and representing the different resources information and state the reasons directly from obtained material. | 3                      | 90                   | 70.31%     |
| Combining the different representations and develop skills with the real situations that are flexible according to context. | 4                      | 50                   | 39.06%     |
| Evaluating problem solving strategies using wide logical thinking and combining knowledge and skills of mathematic with the real situations. | 5                      | 2                    | 1.56%      |
| Doing the conceptual, generalization and using information base on investigation and modeling on the complex problem situations. | 6                      | 0                    | 0%         |

Based on Table 3 about the results of achieving students' mathematical literacy skills in general that at first level many students are able to complete and have a high ability that is 87.50%, at the second level student ability begins to decline by 11.72% from before, the third level students fewer decreases compared to the previous decline ie decreased by 5.47%, the fourth level many students are unable to solve problems in developing skills and combining representation so that the percentage has decreased to 31.25% then at the fifth level there are only a few children who are less able to do a strategy of merging reasoning and skills so that the percentage has decreased very significantly reaching 37.5% and at level 6 no one student is able to solve the problem. This can be seen clearly that the mathematical literacy ability of students has a general average of 45.70% in the low category where it can be seen in the categorization of mathematical literacy abilities.

Table 3. Categories of mathematical literacy abilities

| Categories of Mathematical Literacy Capabilities | Score                        |
|-------------------------------------------------|------------------------------|
| High                                            | ≥ 72,82                      |
| Medium                                          | 46,5 ≤ x ≤ 72,81             |
| Low                                             | < 46,5                       |

3.2. Discussion

3.2.1. Analysis of Student Answers Level 1
In the first indicator of identifying information, it can be seen that students have a high ability, namely the average achievement of 87.50%, but there are some students who are still less than optimal in identifying this information so that there are still a few shortcomings and errors in solving problems. This can be seen in Figure 1.

Figure 1. Answer S1

In Figure 1 it can be seen that the students' answers are almost perfect starting from identifying information and then solving problems but in problem solving students still experience confusion between the maximum area and the minimum area so that students carry out shading in the two maximum areas and the minimum area. What should be shaded is the minimum area, which is the outer area bounded by the intersection of the 3 biggest lines with the biggest x and y axes. This can be seen by the results of interviewing the subject (S) with the researcher (R) to find out the deficiencies in the ability of mathematical literacy for high categories.

R : How do you steps use to work on this problem?
S1 : My first step is to find the intersection point in each equation then I draw a graph.
R : Actually you can, but why on the graph are you shading two settlement areas? What was asked about the questions asking for 2 settlement areas?
S1 : I am still confused sir, to distinguish between the settlement areas for maximum profit and which settlement areas for minimum profit, so I shaded both.
R : Try to open the linear program material at the beginning of the chapter, please read for clarity on how to determine the correct settlement area
S1 : Sure sir, apparently I just understood to determine the Settlement area in the inequality of the linear program.

3.2.2. Analysis of Student Answers Level 2

In Table 2 it can be seen that the indicators applying the basic algorithm students have high ability which is 75.78% but there are some students who lack the basic algorithm which is about the maximum profit and minimum profit. This can be seen in Figure 2.

Figure 2. Answer S2
In Figure 2 it appears that the answers of students are almost perfect where students are actually able to apply the basic algorithm in problem solving only students are still incomplete in giving answers namely where the area of maximum profit fund settlement where the location of the maximum settlement area, it is seen that students only know the completion procedural but do not understand what is at issue. Students should be able to complete the location of the maximum settlement area and the location of the minimum settlement area. This can be seen by the results of interviewing the subject (S) with the researcher (R) to find out the deficiencies in the ability of mathematical literacy for high categories.

R: How do you steps use to work on this problem?
S2: My steps are the same as problem number one above the pack, first looking for the intersection point in each equation then I draw a graph.
R: What is asked about the problem is just to draw a graph?
S2: No sir, I don't really understand the settlement area so I only got the graph
R: Try to open the linear program material at the beginning of the chapter, please read for clarity on how to determine the correct settlement area
S2: Well sir, it turns out I just understood to determine the settlement area in the linear program inequality.

3.2.3. Analysis of Student Answers Level 3

The third indicator which is interpreting and representing the source of information about the ability of students to decline in the medium category that is 70.31% most students are wrong in determining the calculation of a large maximum profit. This can be seen in Figure student answers in Figure 3.

In Figure 3 it can be seen that students are actually able to represent the problem but only students are not careful enough to do the calculation and selection of the maximum calculation. Students should calculate the maximum is Rp.14,200,000.00 but students do the calculation of Rp.1,420,000,00 and finally students experience errors in determining the maximum profit. This can be seen by the results of interviewing the subject (S) with researchers (R) to find out the deficiencies in the ability of mathematical literacy for the medium category.

R: What info do you get from that problem?
S3: In this question, I get an inequality function related to the first problem.
R: Are you sure you were ordered to look for it?
S3: Sure sir!
R: Are you sure about the answer you got? Try checking your answer again!
S3: Already sir, I am not careful enough to do calculations.
R: Explain the conclusions you get from the problem in the problem!
S3: In conclusion the maximum profit is Rp.14,200,000.00 but I chose Rp.133,200,000.00 and I am not careful enough to write and calculate well and correctly
R: Have you ever worked on questions like this before?
S3: Already sir, but a little different because here the problem is interrelated with the previous answers so you have to be careful from the start working on it
3.2.4. Analysis of Student Answers Level 4
Table 2 looks at the fourth indicator, which combines different representations and develops the skills of the low category, which is 39.06%. The students experience errors in the development of skills namely in the calculation and selection of functions obtained in solving problems and calculation errors in the previous problem. This can be seen in Figure 4.

![Figure 4. Answer S4](image)

Figure 4 shows the answer of one of the students where the students have failed in combining representations so that they cannot solve the problem properly and correctly and students also have failed in interpreting the previous answers which are interrelated. Students should be more thorough and understand the problems coherently. This can be seen by the results of the interview subjects (S) with researchers (R) to find out the deficiencies in the ability of mathematical literacy for the low category.

R : What info do you get from that problem?
S4 : In this problem I get an inequality function related to the first and second questions, the problem of ordering to find the difference between maximum profit in season A and maximum profit in season B.
R : What steps do you use to work on this problem?
S4 : I think the model of questions like this is almost the same as the questions that I have encountered, sir, but after I reread it turns out that my answer did not answer according to the question because I have not encountered a problem model like this.
R : What do you think about this? difficult or easy?
S4 : It's hard, sir, because I'm not used to accepting model problems like this.

3.2.5. Analysis of Student Answers Level 5
In the fifth indicator that can be seen in Table 2 namely evaluating problem solving strategies with thinking and reasoning many students are unable to solve there are only a few students who are able but have failed in reasoning to solve problems so that on this indicator the average student is classified as low namely 1 , 56%. This can be seen in Figure 6 which is the result of one student's answer.

![Figure 5. Answer S5](image)
In Figure 5. It can be seen that students are actually able to evaluate the previous answers to form a completion strategy, but the student made a mistake in entering the numbers used in solving the problem. Students should have an area of 100 x 0.6 for cassava, the result is 60 hectares and fertilizer used 5 x 100 is 500 kg of fertilizer. For the rest of the land and the remaining fertilizer for corn plants, 40 hectares with 240 kg of fertilizer used. This can be seen by the results of the interview subjects (S) with researchers (R) to find out the deficiencies in the ability of mathematical literacy for the low category.

\begin{itemize}
  \item [R] What do you think about this? difficult or easy?
  \item [S5] Very difficult, sir.
  \item [R] From what are you ordered to do this?
  \item [S5] Told to look for land area and the amount of fertilizer used for maximum profit in season A and season B
  \item [R] Have you ever worked on questions like this before?
  \item [S5] Not yet, sir. I have never encountered a model about this problem
  \item [R] Are you sure about the answer you got?
  \item [S5] Actually no sir!
  \item [R] Why not sure?
  \item [S5] The problem is I also do not understand how to solve the problem model like this
\end{itemize}

### 3.2.6. Analysis of Student Answers Level 6

In Table 2 can be seen for the sixth indicator namely conceptualization, generalization and using information based on investment, students at this stage were not able to solve the problem so that the average was very low at 0%. Difficulties of students at this stage are mostly new to the types of problems given because in daily materials students only apply procedural and usual reasoning and are not accustomed to conceptualizing and generalizing from problems and then resolving them with their own settlement models. After the interview, it turned out that students said that it was very difficult with this type of problem besides students also had never encountered problems that were so complex and needed the ability to think and reason at a high level to solve the problems. Most students only work according to what is taught by the teacher without any demands to develop student abilities.

From the several problems discussed the ability of students who are high categorized only to the second level of mathematic literacy ability since at first and second level are only applicated where the students have been used to deal the question models and on this level students are only required to identify problems and apply the basic algorithms. The students ability which is medium categorized is only occurs at the third level since at this level students have been required to represent from the resource information obtained but so many students faced the difficulty because during this time students only can solve questions procedurally without understanding correctly how to find the information and represent the information results that have been searched. Students' abilities which is low categorized occurs at the fourth, fifth, sixth level since this level students are required to combine representations from different resources, evaluating the strategies solving and doing the conceptualitation with investigations where the ability or skill on this level are rarely or even never given by teacher so that students can not be able to develop logical thinking ability also develop skills and abilities on the student themself.

Many researchers conduct research on mathematical literacy performance, but only measure the level of literacy performance without examining more deeply the problems that occur in students accordance with the indicators on each level. Based on the research, the researchers found that the level of students' performance only reached third level since at third level students have limits to understand how to apply their performance, at fourth level students experienced limitations in understanding complex problems, a fifth level teachers are very rarely give questions that demand students to use thinking and reasoning performance and at sixth level students are very rarely to develop the performance to apply it that require very complex thinking and reasoning. Researchers experience the leakiness in the limited instruments on the program material, the limited research subjects are only 32 students and the limited time the
subject is in completing the test, so it is highly recommended for further researchers to be developed for other material without experiencing subject limitations and the time when the subject completes the test.

4. Conclusions
This research showed that the results of student’ mathematic literacy performance only reach on the third level, those were only representing the resource information. The first indicator was 87.50% with the highest categorized. The second indicator was 75.78% with the higher categorized. The third indicator was 70.31% with the medium categorized. The fourth indicator was 39.06% with the low categorized. The fifth indicator was 1.56% with the lower categorized and on the sixth indicator was 0% with lowest categorized, so that overall could be seen the average mathematic literacy performance for student grade XI IPA 1 for 45.70% with low categorized. The need performance in the recent period was student’ performance to develop and apply their performance on daily life, so that the researches advised teacher should not push the routine comprehension procedural but also variety in giving problem [15]. The problem aimed on the developed logical thinking so the students could usually face the next period and un-update in logical thinking to solve problem [2]. In addition to, teachers must be used to their students to use mathematic skill to face problems solving appeared, doing the generalizations on the performance got during learning, interpreting, and giving the reasons for a problem with the mathematic performance that had been gotten.

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