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Statistic literation profile viewed from thinking level Middle Order Thinking Skills (MOTS)

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Abstract. Purpose of this study is to describe the statistical literacy skills of prospective teacher students in terms of Middle Order Thinking Skills (MOTS). Students should have basic statistical competence so that they can respond, understand, analyze, interpret, and make conclusions about various information related to statistics and can give meaning to problems raised through statistical information in various literacy media. The level of MOTS thinking in bloom revision taxonomy includes remembering (C1), applying (C2) and understanding (C3). This research is a qualitative research. The subjects of this study were students of mathematics education study programs who took statistics statistics. Researchers developed a statistical literacy ability test that would measure competencies in terms of the level of thinking of MOTS, namely: understanding statistical concepts, insight into statistical concept applications, numeracy skills and the ability to present statistical data. The test instrument is then given to the research subject and analyzed descriptively. The results showed that the statistical literacy ability of students in terms of MOTS showed that 19% in the low category, 28.6% in the Medium category and 52.4% in the high category

1. Introduction

Statistics is a branch of applied mathematics which consists of theories and methods on how to collect, measure, classify, calculate, explain, synthesize, analyze and interpret data obtained systematically [1]. Statistics plays an important role in various human activities. Statistics can be applied not only in mathematics but can be applied in sharing other fields of science, including social, economic, industrial, education. Statistics can be used to compile a plan, calculation, data analysis, and decision making [2]

Once the importance of statistics, so that at the level of secondary schools (SMP / MTs) and upper levels (SMA / SMK / MA) to tertiary institutions, statistics become the material contained in the curriculum that must be taught. In the school curriculum, statistics are integrated in mathematics. Unlike the school curriculum at the tertiary level, statistics are taught separately not integrated in mathematics. However, the role of mathematics really determines the success of students in mastering statistics.

The basic competencies expected in statistical learning at tertiary institutions are awareness of the importance of understanding data; can understand the basic concepts of statistics and their terminology; have knowledge about how to collect data and the ability to describe it; have data interpretation skills; and as a basis for communication **[3].** Prospective teacher students should have basic statistical

competencies so that they can respond, understand, analyze, interpret, and make conclusions about various information related to statistics and can give meaning to problems raised through statistical information in various literacy media [2]. In line with the development of knowledge, understanding and understanding of literacy continues to be developed and applied in various fields, including literacy in the information field better known as information literacy, media literacy, scientific literacy, mathematical literacy, and statistical literacy (statistical literacy).

Wardhani, S and Rumiati [4] state that, "Statistical literacy is the ability of a person to formulate, apply and interpret mathematics in various contexts, including the ability to make reasoning statistically and use concepts, procedures, and facts to describe, explain or predict an event. "Furthermore, according to de Lange [5], statistical literacy is not limited to the ability to carry out a number of ways or procedures, and have basic statistical knowledge that enables students to be able to live in a difficult and sufficient situation with only what they need. Statistical literacy also includes knowledge, method. and statistical processes that are used in various contexts that inspire and provide insight into thinking. Statistical literacy is a set of abilities that students can use to understand a variety of statistical information that is displayed in various media. Statistical literacy is based on the process of interaction through knowledge and critical attitudes. The knowledge element involves cognitive components such as skills, statistical knowledge, mathematical knowledge, knowledge of context and critical questions [6][7][8]

Anderson & Krathwohl in [9] classify the dimensions of the thinking process into three cognitive levels, namely (1) low-level thinking skills (Low Order Thinkhing Skill / LOTS) including the dimensions of the thinking process; know (remember), (2) middle-level thinking skills (Middle Order Thinking Skill / MOTS) include the dimensions of the thinking process; understand and apply, and (3) higher order thinking skills (HOTS) include the dimensions of the thinking process; analyze, evaluate and create (create).

Based on the results of observations of a number of Ahmad Dahlan University Mathematics Education teacher candidates who are taking Elementary Statistics lectures, it indicates that the students' statistical literacy skills have not achieved the expected results, because students still have difficulty reading the symbols used in statistics, such as distinguishing the use of sigma notation. to express the amount ($\sum$) and the sigma notation to express the standard deviation (σ). In addition, students also still have difficulty interpreting the conclusions from a hypothesis test. Weak statistical literacy skills are due to the lack of statistical literacy skills and the inability of students to use statistics in their daily lives [6][7][10].

To optimize students' statistical literacy skills, an initial effort is needed, namely by describing the extent to which the students' statistical literacy skills of prospective mathematics education teachers are carried out by conducting an in-depth study of statistical literacy abilities, so that an overview of students' statistical literacy abilities is needed to further be a recommendation to make efforts to improve statistical literacy skills.

2. Methods

The Research method used in this research is descriptive qualitative method with the type of research strategy that is the type of case study. This research was conducted at the Mathematics Education Study Program FKIP Ahmad Dahlan University. The population as well as the sample in this study were students of the Mathematics Education Study Program who took the statistical clusters.

In this study the researcher is the main instrument. In addition, there are statistical literacy ability test instruments based on MOTS thinking levels. The statistical literacy ability test instrument includes 4 questions with indicators, namely: 1) Understanding of statistical concepts, 2) Insights into the application of statistical concepts, 3) Counting skills and 4) Ability to present statistical data.

Classification of thinking dimensions according to Anderson & Krathwohl in [9] (Ministry of Education and Culture, 2017) is presented in the following table:

Table 1. Classification of Thinking Dimensions of Thinking

Levels Levels of Thinking	Levels in Bloom's Taxonomy Revision of	Indicators Literacy Statistics
HOTS	Creates (C6)	
	Evaluating (C5)	
	Analyze (C4)	
MOTS	Applying (C3)	· Insights into the application of the concept of Statistics
	Understanding (C2)	· Numeracy Skills
		· Ability to present statistical data
LOTS	Remembering (C1)	Understanding statistical concepts

Description:
HOTS: *Higher Order Thinking Skills*
MOTS: *Middle Order Thinking Skills*
LOTS: *Lower Order Thinking Skills*

Qualitative data analysis techniques carried out referring to Bogdan's opinion which includes 1) data reduction, 2) data presentation, and 3) verification. Bogdan stated that data analysis is the process of systematically searching and compiling data obtained from interviews, field notes, and other materials so that they can be easily understood and the findings can be shared with others [11].

Reducing data means summarizing, choosing the main points, focusing on the things that are important, looking for themes and patterns and removing unnecessary. Statistical literacy test results that have been collected into data to be analyzed. The data reduction stage in this study includes: 1) completing statistical literacy test questions; 2) Correcting test results; 3) Analyze test results.

In this study, the data presentation was carried out in the form of descriptive text, tables, figures and diagrams. By presenting data, it will be easier to understand what is happening, to plan further work based on what has been understood. In this study, the presentation of data includes presenting test results in tables and diagrams. From the results of the presentation, the conclusion is in the form of finding data so that it can be described and can answer the problem in this study.

The third step in this research is drawing conclusions and verification. Verification in this study was carried out by comparing test results. Furthermore, conclusions can be drawn about the statistical literacy profile of students in terms of the level ofthinking*Middle Order Thinking Skills* (MOTS).

3. Results and discussion

Qualitative data were processed using MS Office Excel to calculate the overall statistical literacy ability. The following statistics describe theliteracy capabilities of *Middle Order Thinking Skills* (MOTS) overall

Table 2. Statistics description of statistical literacy abilities

Respondense	21
Mean	13,62
Standar deiation	1,77

Higher Score	16
Lower Score	11

Based on the average data and standard deviations above, it can be grouped categories of research subjects on high, medium and low statistical literacy abilities. From the category of students' statistical literacy abilities, 11 students are in the high category, 6 students are in the medium category, and 4 students are in the low category. The presentations for each category are 52.4% of students in the high category, 28.6% of students are in the medium category, and 19% of students are in the low category, more concisely shown in the following diagram.

Table 3. Statistics description of statistical literacy abilities

Category	Number	Percentage (%)
Low	4	19%
Medium	6	28.6%
High	11	52.4%

Based on the table, it can be seen that most of the statistical literacy skills of students in terms of the level of thinking of MOTS are in the high category.
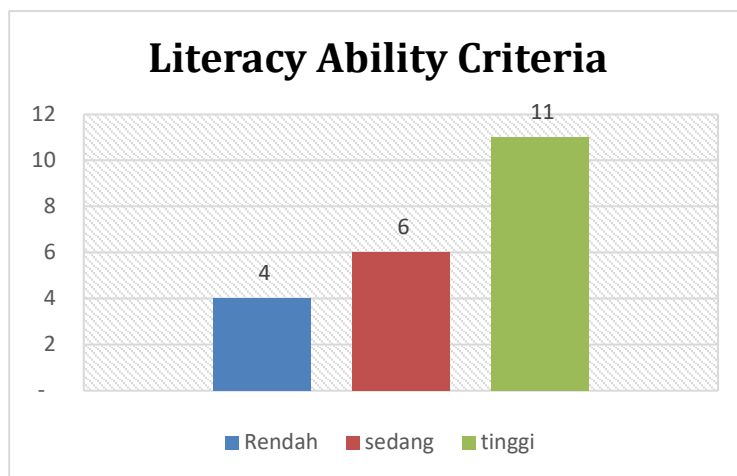
Figure 1. Literacy ability criteria diagram

Based on the diagram above, it appears that most students have statistical literacy abilities in terms of the level of thinking of MOTS in the high category.

Furthermore, it will describe the ability of statistical literacy in each category, namely: 1) the ability of high category literacy, 2) the ability of statistical category moderate literacy, 3) the ability of statistical category low literacy is described as follows:

3.1. High category literacy skills
Here are the results of students' answers with high category literacy abilities on indicators of understanding statistical concepts

Figure 2. Answers to question no b

In question b, students are asked to determine the average deviation, standard deviation values and mode. Students with high literacy skills are able to write formulas correctly, along with index writing on sigma notation.

Furthermore, the application insight indicators and statistical concepts, respondents can apply statistical concepts in solving problems related to statistics. In Figure 2 it can be seen that the respondent is able to use the formulas that have been learned to solve the problem in accordance with the problem commands.

For the numeracy skills indicator, using the help table, respondents can be able to calculate the average deviation value, standard deviation value and mode correctly. The calculation process can be seen in the following image:

Figure 3. The process of calculating question no b

The next indicator is the ability to present statistical data. In questions a and c, students are asked to complete the frequency distribution table and present it in the form of histograms and bar charts. In this process the respondent can complete the frequency distribution table correctly, where the respondent must determine the lower end and upper end of the interval and the frequency is still empty following the respondent's answer shown in Figure 4

Figure 4. Answer no a

In answering question c, the respondent is able to present a correct and complete bar and histogram diagram. Respondents' answers are presented in figures 5 and 6 as follows
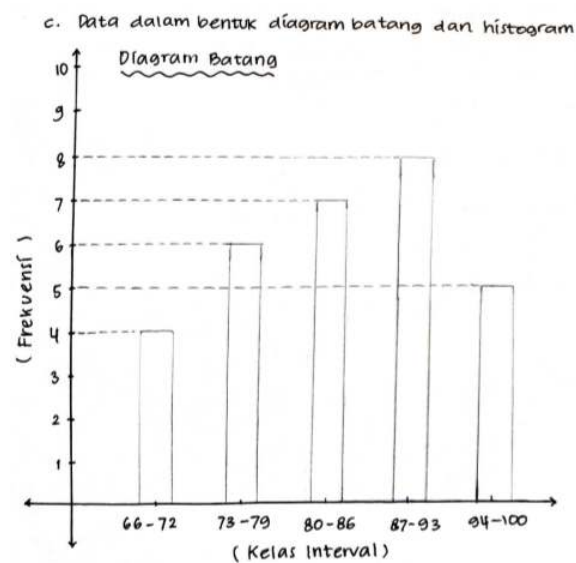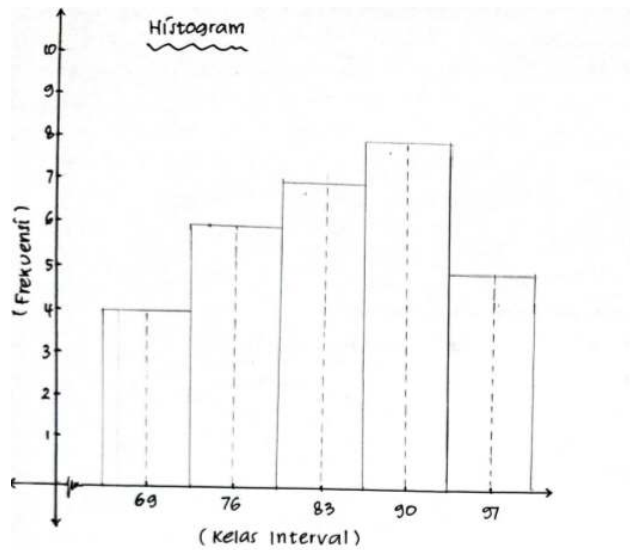

Figure 5. Answer number c

Figure 6. Answer no c

Based on figures 5 and 6, the respondent gives the title in each picture showing that the respondent understands the type and shape of the diagram, then the respondent gives information on the X axis and Y axis lines this shows understanding the information provided and being able to present it in the form of graphs and diagrams

3.2. *Medium category literacy ability*
Here the results of students' answers with medium category literacy ability are indicators of understanding statistical concepts
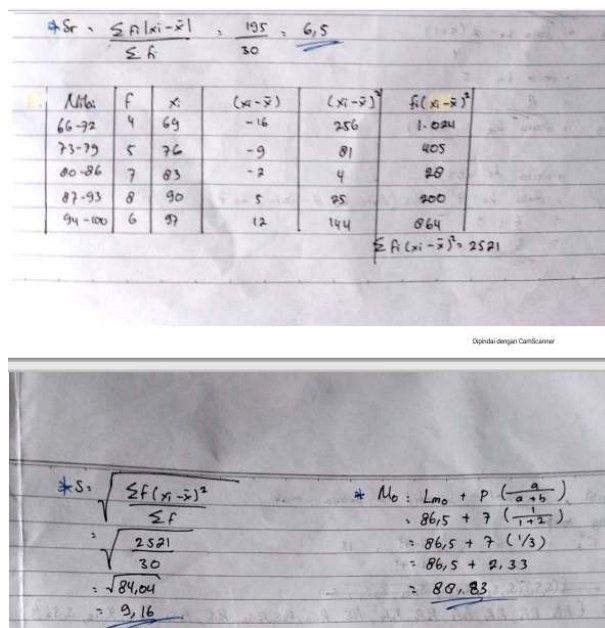

Figure 7. The answer to question no b

In question b, students are asked to determine the average deviation, standard deviation values and mode values. Students with moderate literacy skills are not able to write the complete formula, respondents do not write "i" as index notation on sigma. This shows that the respondents did not understand the concept of the formula well, that every notation contained in the formula has a meaningful meaning.

Furthermore, the application insight indicators and statistical concepts, respondents can apply statistical concepts in solving problems related to statistics. In Figure 7, it can be seen that the respondent is able to use the formulas that have been learned to solve the problem in accordance with the problem commands.

For the numeracy skills indicator, using the help table, respondents are able to calculate the average deviation value, standard deviation value and mode. But there was an error in the process of calculating the mean deviation. Error Calculation process can be seen in Figure 8 below:

Figure 8. The answer to question no b

Based on Figure 8, it is shown that there was an error in calculating the value $| x_i - \text{mean} |$, where the resulting value should not be rounded but the respondent rounded up, so that a difference in value occurs in the next process.

The next indicator is the ability to present data statistics. In questions a and c, students are asked to complete the frequency distribution table and present it in the form of histograms and bar charts. In this process the respondent can complete the frequency distribution table correctly, where the respondent must determine the lower end and upper end of the interval and the frequency is still empty following the respondent's answer shown in Figure 9

Figure 9. Answer no a

In answering question c, the respondent is able to present a correct and complete bar and histogram diagram. Respondents' answers are presented in figures 10 and 11 as follows
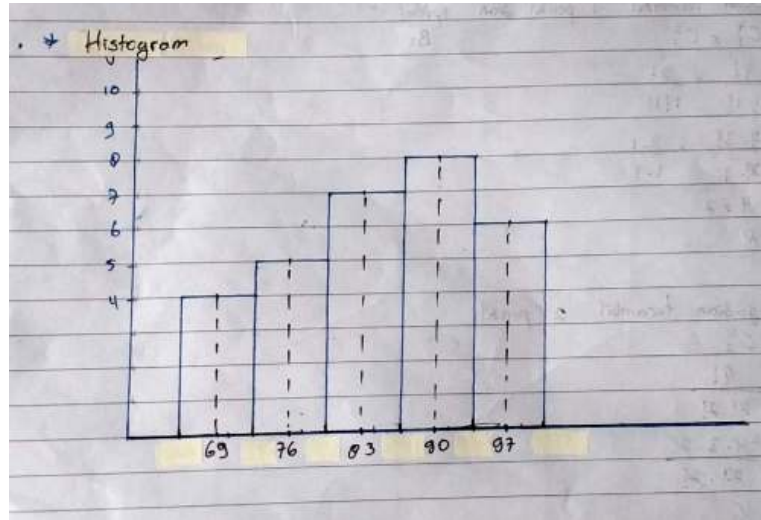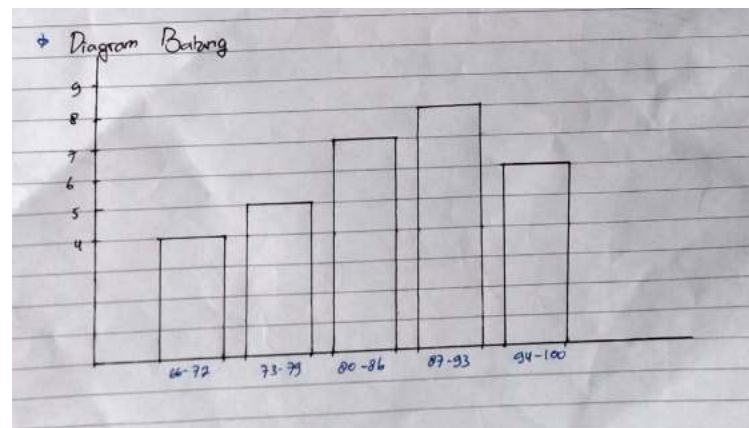

Figure 10. Answer no c

Figure 11. Answer no c

Based on figures 10 and 11, the respondent gives the title in each picture showing that the respondent understands the type and shape of the diagram, but the respondent does not provide information on the X axis and Y axis lines, this indicates that he has not been able to fully present information in the form of graphs and diagrams.

3.3. *High* category literacy ability
Here are the results of the answers of students with low category literacy ability on indicators understanding statistical concepts
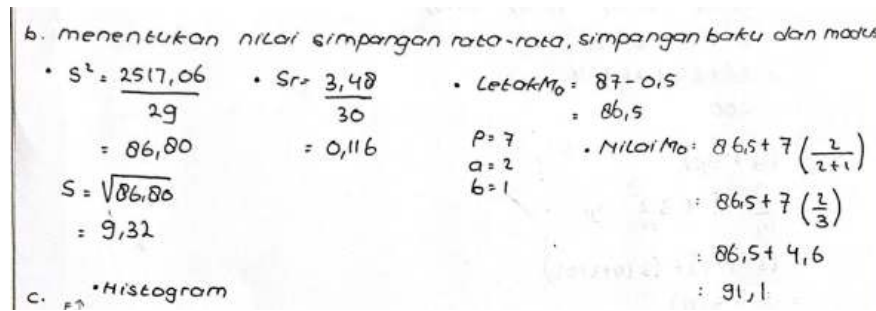
Figure 12. Answer question no b

In the question b students are asked to determine the average deviation, the standard deviation value and mode. Students with low literacy skills do not write down formulas in the work process. This shows the respondent has not been able to work on the problem with good procedures.

Furthermore, the application insight indicators and statistical concepts, respondents can apply statistical concepts in solving problems related to statistics. In Figure 12, it can be seen that the respondent did not write the formula but directly used the formulas that had been learned to solve the problem in accordance with the problem commands.

For the numeracy skills indicator, using the help table, respondents can be able to calculate the average deviation value, standard deviation value and mode. But there is still an error in calculating the average deviation value and mode value. The calculation error of the mean deviation can be identified from the error in the process of calculating $| x_i - mean |$, where the value should always be positive because it is absolute. The calculation process can be seen in Figure 13 below:

Figure 13. The process of calculating question no b

The next indicator is the ability to present statistical data. In questions a and c, students are asked to complete the frequency distribution table and present it in the form of histograms and bar charts. In this process the respondent can complete the frequency distribution table correctly, where the respondent must determine the lower end and upper end of the interval and the frequency is still empty following the respondent's answer shown in Figure 14.

Figure 14. Answer no a

In answering question c, the respondent is able to present a correct and complete bar and histogram diagram. Respondents' answers are presented in figures 15 and 16 as follows
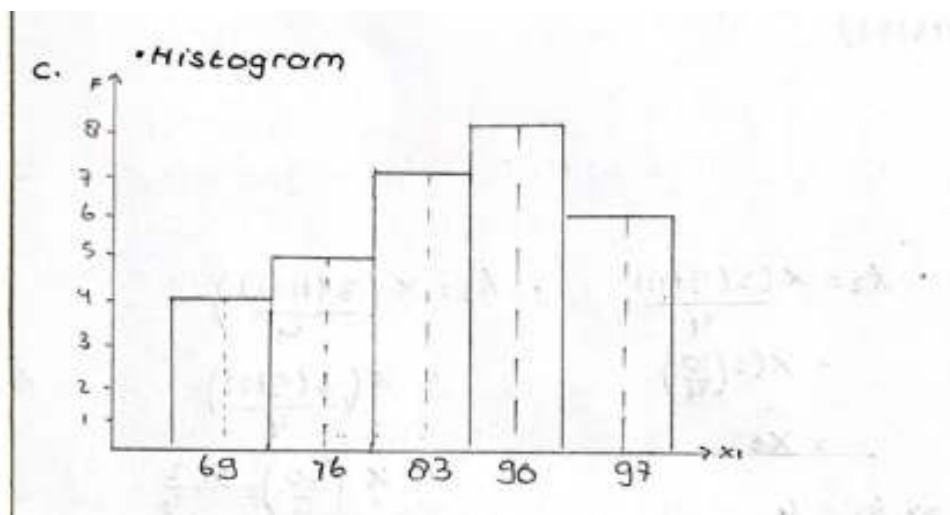

Figure 15. Answer no c

Based on figures 15 and 16, the respondent gives the title in each picture showing that the respondent understands the type and shape of the diagram, but the respondent does not provide information on the X axis and Y axis lines, this indicates that he has not been able to fully present information in the form of graphs and diagrams. Then the respondent's error occurred in presenting the bar chart, where the diagram is presented in the form of a histogram. This indicates that the respondent has not been able to identify the type and shape of the diagram.

Based on the description above, the statistical literacy ability of mathematics education students in terms of MOTS still has not reached the high category, even though most are already in the high category. This can be seen from the percentage of student achievement after completing the literacy test, the literacy ability of students in the low category 19%, and the moderate category 28.6%, the rest are students with literacy ability in terms of MOTS with a high category of 52.4%.
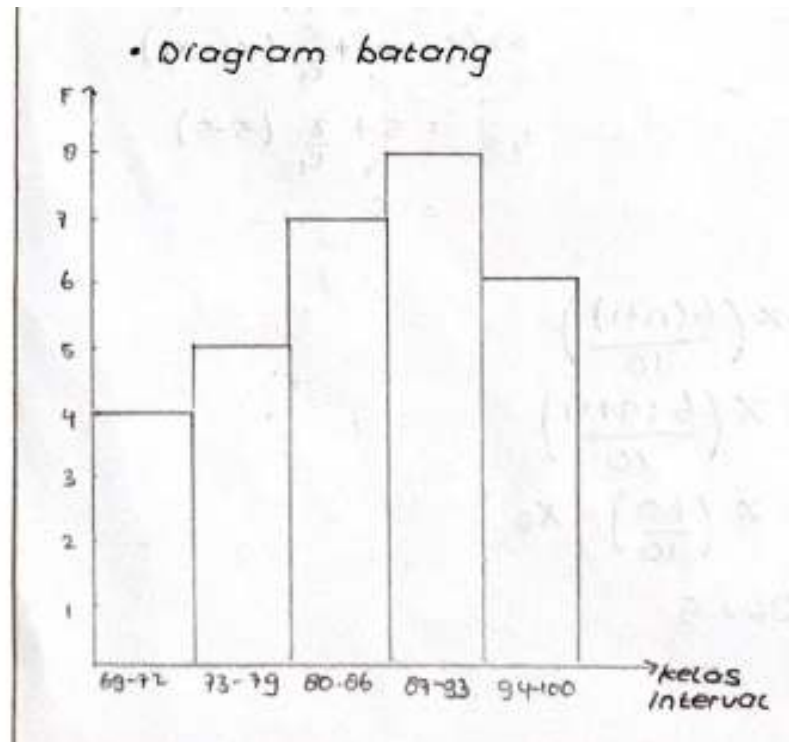
Figure 16. Answer no c

Based on the description above, some of the errors that occur in respondents are misconceptions on statistical objects. [12] have offered a framework, and based on their character can also be applied to measure: (i) general errors in procedural abilities, (ii) misconceptions about notations, offerings or sentences used to present concepts, (iii) difficulties in understand and justify certain traits, and (iv) the difficulty of using concepts in various relationships.

Mathematical learning reform is very influential in the learning process of statistics and probability. The statistical idea has its own substance and reasoning model, therefore the pedagogical framework that is designed must pay attention to these characters. The question is, "what does the teacher need to know about statistical learning in an effort to help students learn?" [13]**,** suggests a synergy between content-pedagogy-technology.

Furthermore, according to [13] learning statistics should be oriented to higherthinking /*orderHigher Order Thinking Skills* (HOTS), where students or students are able to have problem solving abilities, have skills flexible in applying to problems that are not routine.

In this study, a literacy ability profile is presented in terms of MOTS. And the results show that there are still 47.6% still in the low and medium categories. This means that there is still a need to improve the ability of student literacy statistics so that they have skills oriented to higher-order thinking

4. Conclusion
Based on the results of research and discussion it can be concluded that:

a. The statistical literacy ability of students in terms of MOTS shows that 19% in the low category, 28.6% in the Medium category and 52.4% in the high category.

b. In high literacy skills, respondents are able to write formulas correctly, along with writing indexes in sigma notation, respondents are able to use formulas that have been learned to solve problems according to the problem commands, respondents are able to calculate average deviation values, standard deviation values and modes correctly, respondents can complete the frequency distribution table correctly and respondents are able to present bar charts and histograms correctly and completely.

c. In the medium literacy ability, unable to write the complete formula, the respondent does not write "i" as an index notation on sigma, the respondent is able to use the formulas that have been learned to solve the problem in accordance with the problem command, the respondent is able to calculate the average deviation value, the respondent is able to calculate the average deviation value, standard deviation value and mode, but there is an error in the process of calculating the average deviation value, the respondent can complete the frequency distribution table correctly and the respondent is able to present a true and complete bar and histogram diagram.

d. At low literacy skills, respondents are not able to write formulas in the process of working, respondents can apply statistical concepts in solving problems related to statistics, but respondents write formulas but directly use the formulas that have been learned to solve problems according to the problem commands, respondents are able to calculate average deviation value, standard deviation value and mode correctly, but there is still an error in calculating the average deviation value and mode value, respondents can complete the frequency distribution table correctly and the respondent is able to present a bar diagram and histogram but respondent errors occur in presents a bar chart, where the diagram is presented in the form of a histogram

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