15. Analysis of Students' Errors in Solving Statistical Problems:

by Inggi Mayani

Analysis of Students' Errors in Solving Statistical Problems: A Case of 8th Grade Students at SMPN 4 Siak Hulu, Indonesia

Inggi Mayani, Suripah*, Ilham Muhammad
Department of Mathematic Education, Universitas Islam Riau, Indonesia

Abstract: The purpose of this research is to describe and analyze the mistakes made by students when working on math problems in statistics material. This research was conducted in class VIII SMPN 4 Siak Hulu, with 10 students as research subjects. This type of research is a qualitative descriptive research. Data collection techniques are using tests, and unstructured interviews. The results showed that: 1) there were 4 types of errors, namely conceptual errors by 30%, fact errors by 4%, procedural errors by 14%, and technical errors by 10%; 2) there are 5 indicators discussed related to statistical material, namely indicator 1 (Determining the average value of a data), indicator 2 (Analyzing data), indicator 3 (Determining the median of even data), indicator 4 (Determining the mode value of a data), indicator 5 (Determining the values of the first, second and third quartiles in group data). In the fifth indicator, only 3 out of 10 students were able to answer correctly or 30%, this is the indicator with the lowest percentage of the five indicators; 3) the cause of student errors is the lack of student understanding of the prerequisite material for that solution in order to overcome similar errors, namely by always checking student understanding regarding prerequisite material before starting the lesson and choosing appropriate learning methods and strategies so that students can easily understand the material being taught..

Keywords: students' error analysis, statistics learning, junior high school students.

Abstrak: Tujuan penelitian ini adalah untuk mendeskripsikan dan menganalisis kesalahan yang dilakukan siswa dalam mengerjakan soal matematika pada materi statistika. Penelitian ini dilakukan di kelas VIII SMPN 4 Siak Hulu, dengan subjek penelitian sebanyak 10 siswa. Jenis penelitian ini adalah penelitian deskriptif kualitatif. Teknik pengumpulan data yaitu menggunakan tes, dan wawancara tidak terstruktur. Hasil penelitian menunjukkan bahwa: 1) terdapat 4 jenis kesalahan yaitu kesalahan konsep sebesar 30%, kesalahan fakta sebesar 4%, kesalahan prosedur sebesar 14%, dan kesalahan teknis sebesar 10%; 2) ada 5 indikator yang dibahas terkait materi statistika yaitu indikator 1 (Menentukan nilai rata-rata dari suatu data), indikator 2(Menganalisis data), indikator 3(Menentukan median dari data genap), indikator 4 (Menentukan nilai modus dari suatu data), indikator 5(Menentukan nilai kuartil satu, dua, dan tiga pada data kelompok). Pada indikator kelima, hanya 3 dari 10 siswa yang mampu menjawab dengan benar atau sebesar 30%, ini menjadi indikator dengan persentase yang terendah dari kelima indikator ; 3) penyebab kesalahan siswa adalah kurangnya pemahaman siswa mengenai materi prasyarat untuk itu solusi agar mengungangi kesalahan serupa yaitu dengan selalu mengecek pemahaman siswa terkait materi prasyarat sebelum melulai pelajaran dan memilih metode dan strategi pembelajaran yang tepat agar siswa mudah dalam memahami materi yang diajarkan.

Kata kunci: analisis kesalahan siswa, pembelajaran statistika, siswa SMP .

▪ **INTRODUCTION**

The development of the times has brought enormous growth to the world of education (Muhammad et al., 2022). According to (Sudarsana et al., 2019; Widyanti et al., 2021) education is a conscious effort in creating a learning process that can develop students' potential and become human beings with noble character. In education, a subject that is important and closely related to human life is mathematics (Putri et al., 2019; Simamora et al., 2018; Widada et al., 2018). According to (Agustini & Pujiastuti, 2020; Fatimah et al., 2019) structured science or exact science which is the basis for other sciences and is closely related to one another is mathematics. Meanwhile, according to Nuraeni (2020), mathematics can train students to think logically, rationally and carefully. A rational, logical and careful way of thinking is a mindset that students must have in solving various problems in everyday life (Muhammad & Yolanda, 2022; Susanti & Suripah, 2021). So mathematics is an important knowledge for students to acquire which is useful in solving problems in everyday life.

Learning mathematics is a learning experience that students receive through a teaching and learning process to gain an understanding of the mathematical material being studied (Asridayanti & Sari, 2021). According to (Amsari, 2018) learning related to mathematical principles that are closely related to one another is learning mathematics. Not a few students who in solving problems still make mistakes, this is due to a low understanding of the concept (Suripah & Susanti, 2022). (Gustianingum & Kartini, 2021; Yadrika et al., 2019) conceptual errors are the dominant errors students make. There are various types of errors in solving problems, apart from errors in understanding concepts there are also errors in facts, principles and operations. According to (S. Amelia & Yadrika, 2019) that the analysis of errors in solving problems carried out by students is divided into four types of errors, namely, 1) conceptual errors; 2) fact errors; 3) principle error; 4) operation error.

One of the materials in mathematics learning that is studied by students at the junior high school level is statistics (Amalia, 2020; M. Amelia et al., 2020; Rahayu & Purwasih, 2020). According to (Sa'adah & Sumartini, 2021) statistical material is very important material that studies data presentation, determines the mean, mode and median. But not a few students who are less interested in this statistics lesson. (Rahman et al., 2021) the lack of interest of students in statistical material is due to the lack of information that students receive related to the benefits and uses of statistics, students must be given knowledge about it and can also provide statistical material in a fun way so that participants students are interested and motivated by statistics material.

Errors are deviations from the correct answer and are carried out systematically (Ardiawan, 2015; Fazzilah et al., 2020; Ulfa & Kartini, 2021). Meanwhile, according to (Wulandari & Resta, 2018) mistakes are mistakes made by individuals in solving the problems given to them. So, an error is a deviation or mistake made by someone against the actual answer that was made in solving the problem, task or problem given. According to (Fitni et al., 2020; Y Lada et al., 2019) from the pattern of students when solving the questions given, you can find out and see where the mistakes are. Errors in students need further analysis which is intended to obtain information related to types of errors and factors that cause student errors, especially in solving questions on statistical material (Aprilia, 2020; Aulia et al., 2017; Rahmayanti & Maryati, 2021; Sa'idah & Wijayanti, 2022).

Research related to this research is research by (Juliana & Zanthy, 2020) which concludes that in solving problems, especially in statistical material, students' mathematical abilities are still low because there are still many student errors found in solving problems in indicators explaining steps in solving problems clearly in written form. Furthermore, according to (Ashidiqi & Setiawan, 2021) students' difficulties in solving statistical questions, especially in determining the median, are included in the very high criteria, namely by making errors of up to 90%, this occurs because students lack understanding of concepts and are not careful in solving the questions given, and to minimize mistakes made by students, further research is expected to develop methods, approaches and learning media. Meanwhile, according to (Mediyani & Mahtuum, 2020; Sari & Bernard, 2020; Wisesa & Riajanto, 2022) students still make many mistakes in statistical material, especially conceptual errors.

This study aims to describe what mistakes students made in solving statistical questions and to find the causes of student errors in working on statistical problems. According to (Hananta & Ratu, 2019) mistakes made by students must be handled seriously because if they are not resolved they will have a bad impact on students. Therefore, the researcher will analyze the mistakes made by students in working on questions on statistics for class VII SMP.

- **METHOD**

Type of research is descriptive qualitative research. This study aims to describe and analyze the mistakes made by students in solving math problems in statistics material. The sample in this study were 10 students of class VIII SMPN 4 Siak Hulu. The research sample consisted of 4 students with low abilities, 3 students with moderate abilities and 3 students with high abilities. The research instrument used a description question consisting of 5 questions. The instrument in this study is valid and has a reliability value of 0.76. The test was carried out for approximately 70 minutes. For mathematics class VIII SMPN Siak Hulu, the KKM value set was 75. Unstructured test and interview methods were used in data collection techniques. From the results of student answer sheets in working on the questions given, it can be seen the types of mistakes made by students. Unstructured interviews were conducted based on the results of student answer sheets to find out the causes of errors, what difficulties students faced when working on the questions given. Then triangulation was carried out to test the validity of the data.

- **RESULT AND DISSCUSSION**

From the results of the student answer sheets which were the subjects of this study, it was found that several student errors were found in solving the given statistical questions. As shown in the table below which shows the percentage of student achievement in each indicator.

Table 1. Student test results for each indicator

No	Indicators of Competency Achievement	Students who Answered correctly	Percentage (%)
1	Determining the average value of a data	7	70
	Analyzing data	7	70
3	Determining the median from even data	5	50
4	Determining the value mode of a data	6	60
5	Determining the value of the first, second, and third quartiles in group data	3	30

Table 1 above shows that there are still many students making mistakes, the most mistakes made by students in solving the questions given are in the fifth indicator in determining the quartile value one, two, and three in group data, where only three students answered correctly. In indicator one and indicator 2 as much as 70% of the subjects were correct in answering the questions. In the fourth indicator, 6 students answered correctly and half of the subjects or 50% of students answered correctly in the third indicator. This means that there is no percentage that reaches 100% of students who answer correctly on the competency achievement indicators in solving the given statistical questions.

After the researcher obtained the necessary data, the researcher then analyzed the errors in each question from the results of the answer sheets for 10 research subjects. The types of student errors are divided into 4 parts, namely: 1) conceptual errors; 2) fact errors; 3) procedural errors; 4) technical error. As shown in table 2:

Table 2. Types of errors made by students in each

Student	Problem Problem				
	1	2	3	4	5
	Types of Student Errors				
S1	B	B	B	KK	KK/KP
S2	B	B	KT	B	KK
S3	B	B	B	KK/KF	B
S4	B	B	KK/ KF/KP	KK	KK/KT
S5	KP	KK	B	B	B
S6	B	KP	B	KK	KK

S7	B	B	B	B	B
S8	B	B	KT	B	KK/KP
S9	KP	B	KK	B	KK/KP
S10	KT	KT	KK	B	CC

Note: CC = Concept Error; KF = Fact Error; KP = Procedural Error; KT = Technical Error; B = Correct Answer

From table 2 above it can be seen that only one student answered all the questions given correctly, namely S7, then only one student answered correctly 4 questions, namely S3, four students answered 3 questions correctly, 3 students answered 2 questions correctly and 2 students were only able to answer one question correctly. This means that students still make many mistakes in solving statistical problems. The percentage of each type of error can be seen in the table below; each

Error type	Number of errors	Percentage (%)
concept error	15	30
Fact error	2	4
Procedural error	7	14
Technical error	5	10

Concept errors are the most dominant errors made by student with 15 errors or 30%, this is in accordance with the results of research (Sari & Bernard, 2020) that conceptual errors are the biggest mistakes students make in solving statistical problems. Furthermore, procedural errors became the second most common error after conceptual errors, namely 7 errors or 14%, followed by technical errors by 10%, and factual errors by 4%. This means that conceptual errors need to be given more attention so that similar mistakes do not occur. To see the mistakes made by students in solving statistical questions on each question and indicators are as follows:

Indicator 1: *Determines the average value of a data. The questions given are related to the average or mean value, students are expected to be able to determine the average value of a data. As in question number one,*
Problem 1: *The math test scores of ten students are as follows:*
6, 6, 6, 7, 7, 8, 8, 8, 9, 9.
Calculate the mean of the data!

There were no students who could not work on the questions on indicator 1, but there were 3 students who were wrong in determining the average of the data given in question number 1, the student's mistakes can be seen in the picture below:

Figure 1. Results of student answer sheets in question number 1

From Figure 1, it can be seen that students made mistakes in entering the data that had been given, this was a procedural error. Students should have entered all the data provided, namely as many as 10 data, but students only entered 9 data in solving questions on indicator 1 which resulted in differences in the results obtained. For this reason, interviews were conducted to ascertain the causes of errors made in solving the questions of these students. From the results of interviews conducted with students who made mistakes, in working on question number one the students were in a hurry to work on it and did not check the results of their answers again which resulted in students making mistakes in answering the questions.

Indicator 2: Analyze data. The questions given are related to students' understanding in determining the value of x from the data provided, where the average value is known. As in question number 2 below.
Problem 2: The mean value of the data:
8, 10, 6, 7, 12, 5, 3, x is 8. Then the value of x is?

In the second indicator all students were able to work on question number two which had been given, but the same was the case with the first indicator, namely as many as 3 students made mistakes in solving the problem. This can be seen from one of the results of the student's answer sheet on question number 2 as follows:

Figure 2. The results of the student's answer sheet on question number 2

From the picture above it can be seen that the student made a mistake in terms of the addition operation, where the student answered 50 which is the result of the sum of the data that has been given. However, the correct answer should be 51, which means

that a sum other than 51 is a technical error. Here students answered 50 which resulted in a difference in the results obtained. For this reason, interviews were conducted to find out the causes of errors. Based on the results of interviews conducted with students who made mistakes, it was found that students' lack of accuracy in working on questions on indicators of analyzing this data caused students to make mistakes in solving problems.

Indicator 3: *Determine the median of even data. The questions given are related to the median or median value of an even number of data. In this case the teacher provides 10 data which is an even number of data. As in question number 3 below.*
Problem 3: *The math test scores of ten students are:*
5, 6, 6, 8, 7, 6, 8, 7, 6, 9.
a). Sort the data from the smallest data to the largest data
b). Find the median of the data?

In this indicator, all students filled out their answer sheets, only 5 students answered correctly. However, there was one student who made a mistake in facts, concepts and procedures as shown in the results of the student's answer sheet in question number three below:
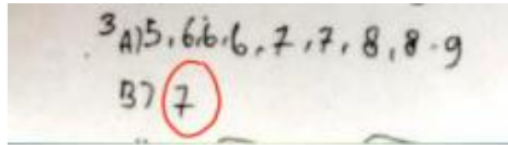

Figure 3. Results of the student's answer sheet in question number 3

From the Figure 3, in the answer to part a, the student did procedural errors where the data worked on by students is incomplete or does not match the data given in the question, this affects the answer to part b, where to find media, precise and complete data is needed. In part b, students immediately answer 7. This is a fact error where students are unable to write the symbol of the median. Students are unable to answer with steps or do not write down the process of making conclusions, which means that students have made procedural errors due to a lack of understanding of students' concepts which results in students making conceptual errors. For this reason, the researcher conducted interviews to obtain information regarding the reasons why these students made mistakes in solving questions that contained this third indicator. Based on the interviews, it was found that students were not careful in writing or sorting data. Returning and students also did not understand the differences in median, mean and mode which resulted in students making mistakes in answering questions.

Indicator 4: *Determines the mode value of a data. The questions given are related to the values that appear frequently or the mode. Students are given data. Then, the student is expected to be able to determine the mode of the data that has been given. As in question number four as follows.*
Problem 4: *The data below shows the height of 20 people:*
154, 153, 159, 165, 152, 149, 154, 151, 157,158

154, 156, 157, 162, 168, 150, 153, 156, 160, 154
Mode from the data above is?

In this indicator, out of 10 who worked on question 4, they made mistakes, as was done by a student who made a conceptual error. This can be shown from the results of students' answers to question number 4 as follows.

Figure 4. The results of student answer sheets on question number 4.

In Figure 4, it is clear that students made conceptual errors, the error lies in number 165, the correct answer should be 154. For this reason, the researcher conducted unstructured interviews to ask about the causes of the mistakes made. Based on the interviews, it was found that the student did not understand what was meant by mode, he answered that he had forgotten the material related to mode, this was what caused the student not to answer correctly. This is a conceptual error, where students do not understand the concept of mode, do not know the meaning of mode, students can only sort data from smallest to largest.

Indicator 5: *Determine the value of the first, second, and third quartiles in group data. The questions given are related to the quartile material, both the lower quartile and the upper quartile. As in question number five below.*
Problem 5: *The speed of a car crossing the Siak bridge for 1 minute is shown as follows:*
Speed (km/hour) : 40 50 60 70 80 90
Frequency : 2 6 8 8 5 3
Determine the quartiles of the speed of the car crossing the Siak bridge above?

In this indicator, out of ten people working on it, only 3 students answered correctly, 7 other students made mistakes, as shown in the results of the student's answer sheet in number 5 below:
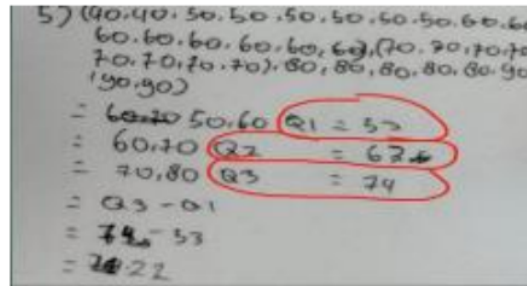
Figure 5. The results of the student's answer sheet in question number 5

From Figure 5, it can be seen that the students did not understand how to do question number five above. The student's error lies in the result of q1 where the correct answer should be 55 but he answered 53, as well as the result of q2. This means that students make procedural errors and conceptual errors. Mistakes in the concept that resulted in the student being wrong in working on the problem. For this reason, it is necessary to conduct interviews to find out the causes of errors, from the results of the interviews it was found that students were confused because there was too much data, and in getting answers to q1 and q2 students did not know the formula for looking for them which resulted in errors in answering the questions. Based on the discussion that has been explained, there are four types of errors made by students in solving questions on statistics material, namely conceptual, fact, procedural, and technical errors. Concept errors are the dominant errors with an error percentage of 30%, followed by procedural errors of 14%, then technical errors of 10%, and errors with the smallest percentage, namely fact errors of 4%, this indicates that students still lack understanding of students' concepts in the material. statistics especially on indicator 5 related to determining the values of the first, second and third quartiles in group data.

- **CONCLUSION**

Based on the results and discussion, there are 4 types of mistakes made by students in working on questions on statistics material, namely: 1) conceptual errors: students do not understand the concepts of mode, mean, median, and quartiles and misunderstand the formula in finding quartiles; 2) factual errors: students have not written the mathematical symbols correctly; 3) procedural errors: students conclude answers without following the correct process or series of procedures; 4) technical errors: students often make mistakes when performing addition and division operations. Concept errors are the dominant errors with a percentage of errors of 30%, followed by procedural errors of 14%, then

Technical errors of 10%, and errors with the smallest percentage, namely factual errors of 4%. For each indicator of competence attainment, students make many mistakes, especially on indicator 5, namely in determining the 1, 2, and 3 quartile values in group data, where only three students answer correctly. In indicator one and indicator 2 as much as 70% of the subjects were correct in answering the questions. In the fourth indicator, six students answered correctly and half of the subjects or 50% of students answered correctly in the third indicator. This means that there is no percentage that

reaches 100% of students who answer correctly on the competency achievement indicators in solving the given statistical questions.

As for suggestions for teachers to pay more attention to students' understanding of concepts by checking the prerequisite material before starting lessons and choosing the right learning strategy so that students can easily understand the material being taught. For further research in order to be able to analyze student errors from a different point of view, you can use other theories, methods or learning models.

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15. Analysis of Students' Errors in Solving Statistical Problems: