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# THE LEVEL OF STUDENT'S STATISTICAL REASONING IN SOLVING STATISTICS PROBLEMS BASED ON GENDER DIFFERENCE

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## ABSTRACT

This study aims to determine the level of students' statistical reasoning. This research was conducted in one of the schools in Donggo District, Bima Regency, NTB Indonesia by taking a sample of 2 students, namely 1 male student and 1 female student. This research is a descriptive qualitative research. Data collection techniques in this study were observation and interviews, while the instruments used were tests and interviews. The test consists of two, namely a test to determine students' mathematical abilities and a test to determine students' reasoning abilities. The results of this study indicate that the level of statistical reasoning of male students is included in the level 5 category because they have done all stages of statistical reasoning correctly, while female students are included in the level 4 category, because female students are not capable of representing the data stage.

keywords. Reasoning Level, Statistical Reasoning, Statistic Problems

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## INTRODUCTION

One of the goals of learning mathematics is that students are solid in reasoning on mathematical patterns and properties, performing mathematical manipulations, and reasoning in solving mathematical problems. NCTM, (2002); Stylianides, et al, (2013); Sukirwan et al., (2018) and (Pradita et al., 2021) agree that it is one of the five basic abilities that are standard processes in mathematics that reasoning students must have. Furthermore, Sukirwan et al., (2018) explained that mathematics is reasoning that every activity in mathematics cannot be separated from reasoning. As a result, reasoning becomes a basic skill that is needed to improve general mathematical abilities.

Mathematical reasoning is the basis for obtaining or constructing mathematical knowledge. Using reasoning in patterns and characters, performing mathematical manipulations in making generalizations, compiling evidence, or explaining mathematical ideas and statements are important things to improve students' reasoning abilities about a mathematical material (Rizqi

& Surya, 2017). Reasoning is a basic mathematical ability that will become a strategic issue in the future which basically always becomes the main concern of a mathematician because of its role in solving mathematical problems, but the implications of reasoning are crucial problems that are always present in everyday learning (Haryani et al., 2018; Sukirwan et al., 2018)

Reasoning is a way of thinking in drawing a conclusion from cases that have been proven. Reasoning is the adoption of thinking to produce statements and to reach conclusions on problem solving which is not always based on formal logic so it is not limited to proof (Kadarisma et al., 2019). Stylianides, et al, (2013) explain that reasoning is identifying patterns, making conjectures and loading arguments from several proofs of a statement that has been assumed to be true or false. Furthermore, Pradita et al., (2021) stated that mathematical reasoning can be mapped into three, namely inductive reasoning, deductive reasoning, and analogical reasoning. Analogous reasoning according to Pradita et al., 2021) is narrowly a decision-making process that is linked based on identification from the source domain to the target domain, while broadly it is interpreted as a form of reasoning based on similarities.

NCTM (2002) explains that there are five mathematical topics that students must understand, namely numbers and operations, algebra, geometry, measurement, data analysis and probability. ). Of the five topics, this research focuses on data analysis which is part of statistics. Statistics according to Hasan (2013) is a science that studies data, namely collecting, processing, analyzing, interpreting and drawing conclusions from existing data, while statistics is a collection of data in the form of numbers or not numbers arranged in the form of tables or diagrams related to data.

Statistics can be used in various fields of science such as economics, health, education and many other fields of science. This is as stated by Carmichael (2010) that at this time statistics have been applied in various fields of daily life, from health to politics. A person should have knowledge of statistics which aims to be able to understand statistical information related to issues in everyday life. This shows the importance of studying statistics. In this study only focuses on descriptive statistics. One of the topics contained in descriptive statistics is the presentation of data.

Presentation of data is one of the main material in mathematics subjects taught to junior high school students. According to Regulation Minister of Education and Culture Indonesia no.24 of 2016 concerning core competencies and basic competencies of junior high school students is to analyze the data by the way it is presented (tables, line charts, bar charts, and pie charts), and present and interpret data in the form of tables, line charts, diagrams bar, and pie charts. One of the problems faced by junior high school students is the problem of presenting data which consists of three types of diagrams, namely bar charts, line charts and pie charts. The results of the initial study conducted by the researchers showed that junior high school students had difficulty in drawing diagrams and drawing conclusions from existing data. In line with that, the results of research by Rosidah et al., (2018) show that there are still many students who cannot represent data in the form of bar charts, graphs, and pie charts.

The purpose of learning statistics is that students understand statistics well in order to obtain information from existing data, criticize and make decisions based on available information. Rumsey (2002). Meanwhile, Ben-Zvi & Garfield (2004) stated that one of the statistical abilities that students must have is the ability to reason statistically. Statistical reasoning according to Garfield (2002) is the activity of reasoning about statistical ideas by using information about statistics. Statistical reasoning is important for students to have. Likewise, Chan et al., (2014); Chan & Ismail, (2014); Martin et al., (2017); Rosidah et al., (2018) also

say that statistical reasoning is the way people reason with statistical ideas and understand statistical information by combining ideas about data to make conclusions and interpret statistical results.

Martin et al. (2017) explained that statistical reasoning is needed about students' cognitive abilities which consist of students' knowledge of statistical information, and students' understanding of statistical concepts. While Dunwoody & Griffin, (2013) explain that statistical reasoning will arise when an individual faces a situation that requires him to make decisions in the context of incomplete information. Most statistical reasoning incorporates ideas about data and probability, leading to the making of conclusions and interpretation of statistical results. The formation of statistical reasoning is closely related to increasing the level of conceptualization at the time of decision making. This increase is in line with the increase in one's competence to build a risk control model. Statistical reasoning will encourage someone not to use ideas that are often used (Régnier & Kuznetsova, 2014).

Chan et al. (2016) in his research mentions that there are five levels of statistical reasoning and at each level has four constructs in statistical reasoning, namely describing data, classifying data and reducing data, representing data, analyzing and interpreting data. Furthermore, Chan et al. (2016) five levels of statistical reasoning and four constructs in statistical reasoning have tested two students with the same results and did not change. This study is a study adapted from research conducted by Chan et al. (2016). In the research of Chan et al. (2016) explained that the level of statistical reasoning in the four statistical constructs did not change, while in this study it will be explained the level of students' statistical reasoning, to what level students can understand statistical processes.

This study focuses on subjects with gender differences. In understanding statistical processes, each student has different reasoning abilities. Hasrul (2009) explains that each student is a unique individual, that is, no individual is the same as another individual. Firmanti (2017) explains Maccoby and Jacklyn's statement that men and women have different abilities, namely: (1) Women have better verbal knowledge than men, (2) Men are superior in visual spatial abilities (spatial vision). ) than women, (3) Men are superior in math skills. Kadarisma et al., (2019) in their research also stated that there was a significant difference between the mathematical abilities of male and female students, one of the assessed mathematical abilities was the ability to analyze mathematics.

## **METHOD**

This research is a descriptive qualitative approach which aims to describe the level of students' statistical reasoning. The subjects in the study were 1 male student and 1 female student. Before selecting the research subject, the researcher conducted a mathematical ability test to 28 students in class VIIA. From the test, it was found that 5 students had high math skills, 16 students had moderate math abilities and 7 students had low math abilities. Based on the results of the mathematical ability test, the researcher determines the research subject by taking male subject 1 and female subject 1. The researcher takes 1 male subject and 1 female subject because if the researcher takes 2 or 3 subjects there will be a bias of research data. And researchers want to get data based on the characteristics of the subjects studied.

The instruments used in this study were the Mathematical Ability Test (TKM), Statistical Reasoning Level Test (TTPS), and interviews that had previously been validated by experts. Mathematical ability test (TKM) was conducted to determine the research subjects consisted of male and female students. Statistical reasoning level test (TTPS) was conducted to determine the students' level of reasoning in solving statistical problems. Interviews were conducted to examine more deeply the results of answers that were not written by students on the answer sheet.

The data analysis technique in this study was carried out by compiling, categorizing the data to arrive at a conclusion from the data analysis to be achieved. Data analysis is the process of systematically searching and compiling data obtained from the results of statistical reasoning tests, interview results, field notes and documentation, by organizing data into categories, describing them into units, synthesizing, compiling into patterns, choosing important names and will learned and draw conclusions so that they are easily understood by themselves or others.

## RESULTS AND DISCUSSION

### Results

#### 1. Statistical Reasoning Level Test (TTPS) Male Subjects (L)

Before determining the level of statistical reasoning of subject L, the data of the statistical reasoning process carried out by subject L must first be analyzed in 4 stages, namely Describing Data, Organizing Data, Representing Data, and Analyzing and Interpreting Data.

##### a. Describing Data Stage

At the Describing Data stage, subject L was asked to identify the problem and determine the appropriate diagram for the problem given. The following is the result of the written answer of subject L in the Describing Data stage.

Diket : Data perbedaan pekerjaan orang tua siswa

1. PNS 20 orang
2. Pegawai swasta 15 orang
3. TNI / Polri 10 orang
4. Pedagang 5 orang
5. Petani 35 orang
6. Tukang kayu / batu 5 orang
7. yang lainnya 5 orang

1. Diagram apa yang sesuai dengan data di atas? Jelaskan mengapa kamu menyuruh diagram tersebut

Jawab

Diagram yang di gunakan sesuai dengan data diatas adalah Diagram garis, karena diagram garis cocok dengan data untuk lingkaran lingkaran perbedaan pekerjaan.

Figure 1. Subject L's answer at the Describing Data Stage

Based on Figure 1 above, student L can mention all the information contained in this question, namely the type of work parents of students who are civil servants 20 people, private employees 15, TNI / Polri 10 people, Traders 5 people, Farmers 35, Carpenters/ Stone 5 people and the other 5 people. Subject L can also correctly name the diagram that will be used to describe the data on differences in the work of parents of students, namely by using a pie chart.

##### b. Organizing Data Stage

In the Organizing Data stage, subject L is asked to explain the mode and average of the data presented and must calculate the value of the mode and average. The following is the result of the written answer of subject L in the Organizing Data stage.

a. Berapakah modus dan rata-rata dari data diatas? Jelaskan

a. Modus

Modus merupakan nilai yang sering muncul, jadi bisa lihat siapa nilai yang sering muncul, dari data 20, 15, 10, 5, 35, 5, 5 atau di susutkan 5, 5, 5, 10, 10, 20, 35. jadi Modusnya adalah 5

b. Rata-rata

$$\bar{x} = \frac{5+5+5+10+20+15+35}{7}$$

$$= \frac{90}{7} = 13,5$$

Figure 2. Subject L's Answer in the Data Organizing Stage

In the Data Organizing Stage, subject L was able to explain precisely about the mode and the average. And subject L was able to correctly calculate the mode and average value of the data on the differences in student work presented, namely with a mode value of 15 and an average value of 13.5.

c. Representing Data Stage

In the Data Representing stage, subject L was asked to make a diagram and explain the steps in making a diagram. The following is the result of the written answer of subject L in the Representing Data stage.

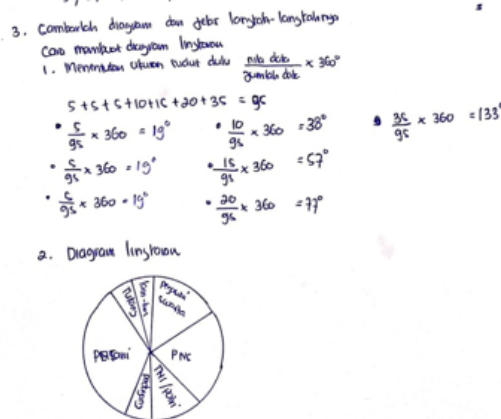


Figure 3. Subject L's Answer at the Data Representing Stage

At the Data Representing stage, subject L can determine the steps to make a circle diagram correctly, namely student L first determines the angle value of the diagram to be made using the formula  $\frac{\text{nilai data}}{\text{jumlah data}} \times 360^\circ$ . After determining the value of the angle of the circle, subject L immediately makes a circle based on the angle that has been determined.

d. Analyzing and Interpreting Stage

In the Analyzing and Interpreting Data stage, subject L asked to look back at the answers that were done and conclude the answers that had been done. The following is student L's answer at the Analyzing and Interpreting Data stage.

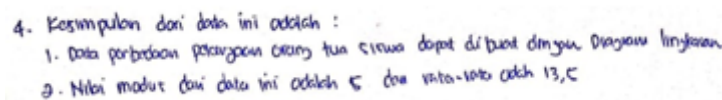


Figure 4. Subject L's Answer at the Data Representing Stage

At the Analyzing and Interpreting stage, subject L can correctly conclude from the answers that have been done. But before giving conclusions from the answers that have been written, subject L conducts a re-analysis of the answers that have been done. This is based on the results of interviews.

P How do you conclude from your answer?  
 Siswa L I reanalyze my answer, is it right or wrong.

From the data exposure to the results of subject L's answers, a table of student achievement was made at all stages of student reasoning indicators.

Table 1. Assessment of Achievement of Statistical Reasoning Stage Indicators

Stage	Indicators	Evaluation
<b>Describing Data</b>	Explaining information on problems presented in the form of tables	√
	Reveal the selected diagram to interpret the data presented in the form of a table	√
<b>Organizing Data</b>	Can explain the concept of mode and determine the mode value of the data presented in the form of a table	√
	Can explain the concept of average and determine the average value of the data presented in the form of a table	√
<b>Representing Data</b>	Can draw diagrams from data presented in the form of tables	√
	Determine the steps in describing the diagram from the data presented in tabular form	√
<b>Analyzing and Interpreting Data</b>	Making conclusions from the data presented in tabular form correctly	√
	Give a conclusion from the answers that have been done	√

Based on the results of data interpretation of subject L's answers and the Assessment Table of Statistical Reasoning Achievement Indicators, students can see that subject L's statistical reasoning is in the level 5 category. Where all indicators of statistical reasoning stages are met. Subject L can complete all requests on the question by giving the correct answer.

## 2. Statistical Reasoning Level Test (TTPS) Female Subjects (P)

Before determining the level of statistical reasoning of subject P, the data of the statistical reasoning process carried out by subject P must first be analyzed in 4 stages, namely Describing Data, Organizing Data, Representing Data, and Analyzing and Interpreting Data.

### a. Describing Data Stage

At the Describing Data stage, subject P was asked to identify the problem and determine the appropriate diagram for the problem given. The following are the results of written answers and the results of the interview subject P stage describing Data.

a. Diagram yang sesuai dengan data diatas adalah diagram lingkaran, karena data ini merupakan data perbedaan pekerjaan orang tua siswa

Figure 5. Subject P's Answer at the Describing Data Stage

- P : Do you know what information I have in the question?  
 Siswa P : Yes sir I know!  
 P : What information do you know?  
 Siswa P : Information on data on job differences for SMPN2 Donggo students  
 P : So which data?  
 Siswa P : The data, yes, this is known. The type of work of parents who are civil servants 20 people, private employees 15, TNI / Polri 10 people, Traders 5 people, Farmers 35, Carpenters / Stone 5 people and others 5 people

Based on Figure 5 and the results of the interview, subject P can mention all the information contained in this question, namely the type of work parents of students who are civil servants 20 people, private employees 15, TNI / Polri 10 people, Traders 5 people, Farmers 35, Carpenters / Batu 5 People and the other 5 people, although student P did not write it down directly, student P expressed verbally the information contained in the questions. Subject P can also correctly choose a pie chart to interpret the data in the problem and student P also gives reasons that the data is very suitable for a pie chart because of the data on differences in the work of parents of students.

b. Organizing Data Stage

In the Organizing Data stage, subject P is asked to explain the mode and average of the data presented and must calculate the value of the mode and average. The following are the results of the written answers and the results of the interview with subject P in the Organizing Data stage.

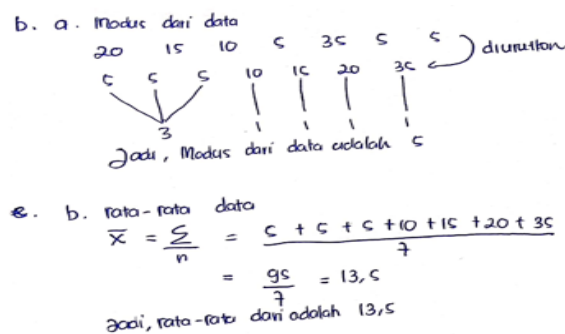


Figure 6. Subject P's Answer in the Data Organizing Stage

- P : What do you know about mode and mean?  
 Siswa P : As I recall, if the value mode that often appears  
 P : If the average value?  
 Siswa P : If the average value is sir, the sum of the total scores continues to be distributed a lot of data

Based on Figure 6 and the results of subject P's interview at the Organizing Data stage, student P was able to explain correctly about the mode and average. And student P is able to correctly calculate the mode and average value of the data on the differences in student work presented, namely with a mode value of 15 and an average value of 13.5.

c. Representing Data stage

In the Representing Data stage, subject P was asked to make a diagram and explain the steps in making a diagram. The following are the results of the written answers and the results of the interview with subject P in the Representing Data stage.

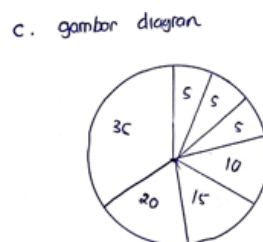


Figure 7. Subject L's answer at the Data Representing Stage

- P : How do you draw this pie chart? Explain the steps!!  
 Siswa P : The trick is to first draw the big circle and then I divide the space on the diagram based on the amount of data available. If the data is big then the space is big, if it's small then the space is small

Based on Figure 7 and the results of the interview with subject L at the Data Representing stage, subject P has not been able to determine the steps to make a circle diagram correctly. Subject P drew a diagram by first making a circle and then partitioning the circle diagram based on the values in the data. Whereas first you have to determine the size of the angle of the circle first.

#### d. Analyzing and Interpreting Data Stage

In the Analyzing and Interpreting Data stage, student P asked to look back at the answers that were done and conclude the answers that had been done. The following is student P's answer at the Analyzing and Interpreting Data stage.

d. kesimpulan yang dapat dibuat adalah diagram yang di pakai, yaitu diagram lingkaran, nilai modus 5 dan rata-rata 13,5

Figure 8. Subject P's Answer at the Data Representing Stage

In the Analyzing and Interpreting stage, subject P can correctly conclude from the answers that have been done. But before giving a conclusion from the answers that have been written, subject P conducts a re-analysis of the answers that have been done. This is based on the results of interviews

From the data exposure to the results of subject P's answer, a table of subject achievement was made at all stages of the subject's reasoning indicator.\

Table 2. Achievement of Indicators of Statistical Reasoning Stages for Students of P

Stage	Indicators	Evaluation
<b>Describing Data</b>	Explaining information on problems presented in the form of tables	√
	Reveal the selected diagram to interpret the data presented in the form of a table	√
<b>Organizing Data</b>	Can explain the concept of mode and determine the mode value of the data presented in the form of a table	√
	Can explain the concept of average and determine the average value of the data presented in the form of a table	√
<b>Representing Data</b>	Can draw diagrams from data presented in the form of tables	X
	Determine the steps in describing the diagram from the data presented in tabular form	X
<b>Analyzing and Interpreting Data</b>	Making conclusions from the data presented in tabular form correctly	√
	Give a conclusion from the answers that have been done	√

Based on the results of data interpretation of subject P's answer and the Assessment Table of Indicators of Achievement of Statistical Reasoning, the subject can see that student P's statistical reasoning is in the level 4 category.



## **Discussion**

### **1. Student Male Statistical Reasoning**

Statistical reasoning for male students at the stage of describing data for male students first analyzes the information on the problem to understand the problem given. After that, the male students wrote down all the information on the answer paper neatly. At this stage, the male students also revealed that a suitable diagram to describe the data in the problem was a pie chart. This shows that the male students at this stage have understood the problems given, so that at this stage the male students have done it correctly. This is in accordance with Sabbag's (2016) statement explaining that in the early stages of statistical reasoning students must understand statistical information.

Reasoning male students at the stage of organizing data, male students can explain and determine the value of the mode and mean of the data presented. Before determining the value of the mode and the mean, the male students also explain the concept of the mode and the mean, then the male students group and sort the data taken on the data presented in tabular form, after that the male students determine the mode and mean values of the data. which have been grouped. This is in accordance with the opinion of Ulusoy & Atlay (2017) which states that at the stage of organizing data students must group data including classifying data, summarizing data. Grouping the relevant data, summarizing the data used and describing the different data.

In the Data Representing stage for male students, it can be seen that male students can make diagrams that match the data presented in the table. Before making a diagram, the male students first explained the steps for making a pie chart by first determining the value of the partition angle on the circle using the formula  $\frac{\text{nilai data}}{\text{jumlah data}} \times 360^\circ$ . After determining the value of the angle on the circle, the male students made a circle diagram based on the value of the angle that had been determined. On this occasion the male students were very skilled in explaining the steps to make a pie chart from the data in the table. This shows that the male students have met the achievement indicators in statistical reasoning in terms of making diagrams on the data and explaining the steps in making diagrams. At the stage of analyzing and interpreting the data, male students made conclusions from the whole process that was asked for in the questions. Before making conclusions, the male students first analyzed the answers that had been done in detail, if something went wrong, the male students would correct it.

Based on the students' statistical reasoning process, male students can determine all processes in performing statistical reasoning, namely the process of describing data; organizing data; representing data and analyzing and interpreting data. This shows that the reasoning of male students is in the level 5 category. This is in accordance with Chan et al. (2016) which explains that students at the level 5 stage of statistical reasoning can perform all 4 stages of statistical reasoning. Furthermore, Ulusoy & Atlay (2016) stated that at the student level, students have full knowledge of statistical processes and are able to solve problems correctly.

### **2. Student Female Statistical Reasoning**

The statistical reasoning of female students at the stage of describing the data of female students first analyzes the information on the problem to understand the problem given. Female students did not write down the information directly on the problem. Even so, female students understand very well the information in the questions. The female students also revealed that the diagram that is suitable for describing the data in the problem is a pie chart. This shows that female students at this stage have understood the

problems given, so at this stage female students have done it correctly. This is in accordance with Sabbag's (2016) statement explaining that in the early stages of statistical reasoning students must understand statistical information.

Reasoning female students at the stage of organizing data, female students can explain and determine the value of the mode and mean of the data presented. Female students do not directly explain about the mode and mean, but female students can explain in words. Before determining the mode and mean values, female students first grouped and sorted the data taken from the data presented in tabular form, after which female students determined the mode and mean values from the grouped data. This is in accordance with the opinion of Ulusoy & Atlay (2017) which states that at the stage of organizing data students must group data including classifying data, summarizing data. Grouping the relevant data, summarizing the data used and describing the different data.

In the Data Representing stage for female students, it can be seen that female students cannot determine and explain the steps in making pie charts. The female student made a pie chart by guessing the size of each partition based on the data. Female students cannot determine the value of the partition angle on a circle using the formula  $\frac{\text{nilai data}}{\text{jumlah data}} \times 360^\circ$ .

This shows that female students do not meet the indicators of achieving statistical reasoning in terms of making diagrams on the data and explaining the steps in making diagrams. At the stage of analyzing and interpreting the data, female students made conclusions from the whole process that was asked for in the questions. Before making conclusions, the female students first analyzed the answers that had been done in detail, if something went wrong, the female students would correct it.

Based on the students' statistical reasoning process, female students can determine the statistical reasoning process at the stage of describing data; organizing data; and analyzing and interpreting data, while at the stage of representing data female students were unable to do so. This shows that the reasoning of female students is in the level 4 category. This is in accordance with Chan et al. (2016) which explains that students at the level 4 stage of statistical reasoning cannot perform all stages of statistical reasoning at high stages such as representing data or organizing data. Furthermore, Ulusoy & Atlay (2016) stated that at level 4 students lacked knowledge about the statistical process of representing data or organizing data.

## CONCLUSION

Based on the results of the research and discussion, it can be concluded that the statistical reasoning of male students is included in the level 5 category because male students can determine all stages of statistical reasoning correctly and as desired. Starting from the stage of describing data; organizing data; representing data to the stage of analyzing and interpreting data. Meanwhile, female students' statistical reasoning was categorized as level 4 because female students could not correctly determine all stages of statistical reasoning. Female students can only determine the stages Starting from the stage of describing data; organizing data; and analyzing and interpreting data. While the stages of representing female student data cannot determine it.

In learning mathematics, teachers should use various approaches, strategies and models of mathematics learning to support and improve students' reasoning abilities. In this case, learning in various mathematical representations will further improve students' ability and level of reasoning.

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