Students' Learning Obstacle in Solving Statistical Reasoning Problems: Epistemological Study

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ABSTRAK
In some cases, Statistical learning only applies some formulas without paying attention to developing students' reasoning ability. So, statistical learning can cause missed conception to the students. A teacher should identify the students' learning obstacles to achieve the learning objectives. This study aims to know the students' learning obstacles in solving statistical reasoning problems from two aspects. The first is from the emic aspect; it is a student's viewpoint toward solving the statistical problem. The second is from the aspect of ethics; it is a student viewpoint toward the teacher's teaching technique done in teaching statistics. This qualitative study employs the explorative case study with epistemology study to discuss the students' learning obstacles. From the test result and interview of three participants, it is concluded that the students face some obstacles in statistical reasoning problem-solving. The teacher also still used conventional methods in teaching the students.
Keyword(s): Keyword: Students' statistical reasoning, Epistemology learning obstacle.

INTRODUCTION

Statistical reasoning is a way of reasoning that uses measurable contemplation and understands factual data by associating one idea with another (Ganesan & Leong, 2020). With statistical reasoning, the students can use ideas and associate them with solving problems. According to (Ulusoy & Altay, 2017), in understanding the context of the problem, one of the ways is by interpreting the data and making conclusions. It becomes a statistical reasoning mindset. Concerning studying statistics, the students must be active so that they are accustomed to using a perspective to interpret a problem. The students should make and test conjectures using data, discuss and explain statistical reasoning, and focus on important big ideas from statistics (Garfield & Ben-Zvi, 2009).

The students have difficulty in learning statistics, one of which is because of its abstract nature. Many students have difficulty understanding statistical concepts, which often causes misconceptions in statistical reasoning (Chan & Ismail, 2012). Abstract statistical material creates misconceptions in students' reasoning, the students need to go beyond the immediate context of the question and draw broader relationships (Callingham

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& Siemon, 2021). If the students ignore statistical abstraction, it will lead to a misconception in statistical learning. This condition can hinder the development of students' statistical reasoning processes.

Several factors resulted in the low statistical reasoning of students, including both from the external and internal side of students and. External factors include the use of monotonous learning techniques. Monotonous learning often makes students feel bored in learning, so the teacher's task is to make better learning techniques. Good learning techniques include involving students in learning. This statement is in line with the opinion (Hendrickson, 2021) that active learning techniques can increase students' excitement, interest, and self-efficacy so that learning using designs centered on student engagement and enjoyment can improve overall student learning. In addition, the teacher's role should motivate the students to be aware of their thinking and reasoning, discuss different solutions to statistical problems, and compare interpretations, assumptions, and explanations (Garfield, 2002). In the current development of the Revolution, students memorize statistical formulas and must apply statistical knowledge in the form of reasoning. Statistical reasoning can be applied in solving problems in everyday life. The students only memorize formulas without a deeper conceptual understanding. This condition is supported by the results of research (Rosidah, Ketut Budayasa, and Juniati 2018) that the ability of high and low-skilled high school students is procedural in completion but weak in conceptual understanding.

The internal factor that causes students' low statistical reasoning is the students themselves. According to (An & Zhang, 2021), the essence of learning is not a series of stimuli and reactions but a cognitive structure formed in the mind. It mainly emphasizes the internal factors of learning, that is, learning for the students themselves. Students' internal factors include motivation, interest, learning style, and others. Obstacles to students' statistical reasoning often come from within the students, so that in this study, we will discuss the obstacles to students' statistical reasoning from the epistemological aspect. The focus of the problem in this study is to look at student obstacles in emic and ethical aspects. The emic aspect is the student's view of his difficulties when solving problems related to statistical reasoning. The ethical aspect is the student's perspective on the teacher's learning techniques when studying statistics.

The objectives of this study include: 1) knowing students' obstacles to understand statistical reasoning; 2) knowing students' perceptions of the teacher's teaching activities in

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learning related to statistical reasoning; 3) knowing students' difficulties in answering problems related to statistical reasoning.

RESEARCH METHOD

The research method used is qualitative research with exploratory case studies. This research was conducted at SMA N 1 Indramayu by taking the subject from class XII. Subjects were selected based on the teacher's recommendation, namely three students with high, medium, and low abilities. In carrying out the research, the subject was asked to solve a static reasoning ability question with indicators using statistical reasoning in solving daily life problems related to bar charts and data center measures. The following is the form of the question given to students:

Figure. 1. Statistical Reasoning Ability Question

In working on these questions, students must complete according to the stage of statistical reasoning proposed (delMas, 2002). Statistical reasoning is categorized as a statistical reasoning process that includes Why?, How?, Explain. So that the indicators of statistical reasoning ability are 1) Why: understand statistical concepts and rules, and express reasons for data, 2) How: provide alternative solutions based on statistical concepts and processes, and 3). Explain: draw conclusions based on concepts, rules, and statistical processes.

After students work on the next questions, the students will be interviewed directly with indicator guidelines; students' understanding of statistical material (worked essay

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questions); students' perceptions of teacher learning, how students answer the questions given, and offer CML Android interactive media. The research data analysis was carried out using an analytical model (Mills, Durepos, & Wiebe, 2012), which consisted of three stages, namely data reduction, data display, and conclusion drawing and verification. Data reduction was collected through video, and voice recording is reduced in the form of random typing and then reduced back in the form of interview text. Display data; at this stage, the results of the interview text will be analyzed with the help of atlas-ti so that it can be easily interpreted. Next, the interpretation stage is to describe the student's statement in the form of text with the student's completion result.

FINDING AND DISCUSSION

The subjects studied were students of SMA N 1 Sindang Indramayu class XII consisting of three students based on the teacher's recommendation. The selected students have studied statistical material with indicators of describing bar charts and determining the size of data concentration, namely the average. The research was carried out at the school, it was intended that students feel comfortable in carrying out the research process. Students are given a statistical reasoning question and asked to solve the problem in 10 minutes. The following are student results and their descriptions.

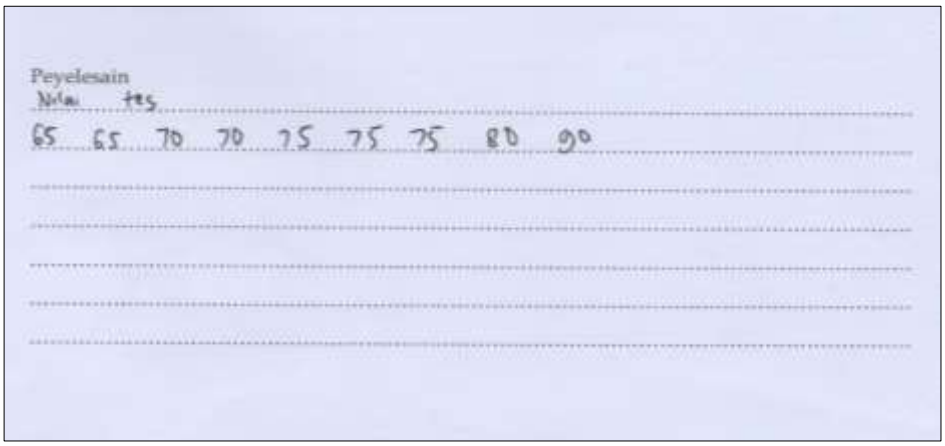

Figure 2. Student 1 completion

Figure.2 is a picture of the completion of the 1st student with low student quality, from the picture it shows that students sort the numbers from smallest to largest, then students only classify test score data. Students do not operate these numbers; this result shows an obstacle to solving statistical reasoning problems that are very complex. This finding is also supported by the interview analysis data shown in the following figure.

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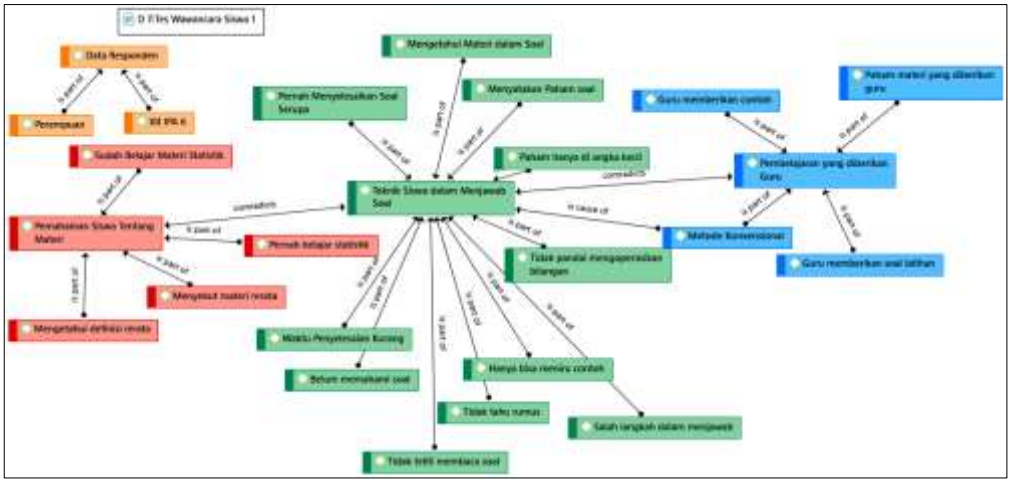

Figure 3. The Interview Result of Student 1

Similar to the completion results, the results of the interviews showed that the 1st student experienced complex obstacles. In the indicators of students' understanding of the material, it was stated by the students that the respondents had previous statistical material, and students could mention and know the definition of the mean. However, the student's understanding of the material contradicted the students' technique in answering statistical reasoning ability, the statement of the technical indicators in answering the questions at the beginning stated that they knew the material in the questions, understood the questions, and had completed the questions. Still, the students took the wrong steps in answering. Students' ability is limited to the calculation of small numbers so that students are not good at operating numbers. The students are also less careful in reading the questions, and the completion time is less and impacts the students' confusion in answering statistical reasoning abilities. The lack of students' ability to answer questions is also a contradiction to the teacher's learning indicators. Students express understanding when the teacher explains, and the teacher also uses active learning techniques such as giving examples, discussing, and practicing the questions. However, the teachers still use conventional methods so it causes the students to be unable to solve the given statistical reasoning problem.

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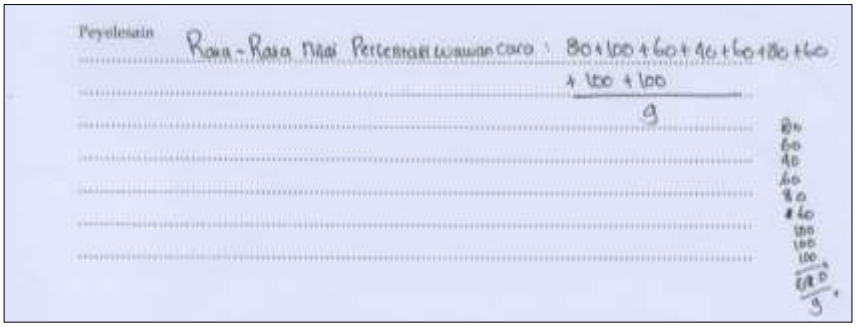

Figure 4. The Solution Result of Student 2

Figure.4 is the result of student 2 with moderate ability in solving statistical reasoning problems. From the figure, we can see that the students only calculate the average value of the interview. It appears that student is trying to add up the numbers with the correct number but stop when dividing the number. Unlike the previous students, this 2nd student tries to add up each number and then divides it, thus students with moderate quality are better than students with low abilities. However, they are still very far from perfect to classify students' statistical reasoning. This result is also shown in the results of the interview analysis as follows.

Figure 5. The Interview Result of Student 2

Figure 5 explains that the respondent is male and has the same major in science. In the indicators of student understanding of the material, the student states that he has studied and understands statistical material, even though he can define the average well. However, this contradicts the technical indicators of students in answering questions. In this indicator, the student states that he has completed similar questions, but because he is nervous and in a hurry to answer, he is not careful in answering. The student also states that he does not understand what the question meant and misinterpreted the question given. The teacher provides the learning with indicators. It also contradicts the students' technique in answering questions. On the learning indicators provided by the teacher, the student states that he understands when studying statistical material. The teacher also provides examples and exercises and discusses so that there is interaction in learning.

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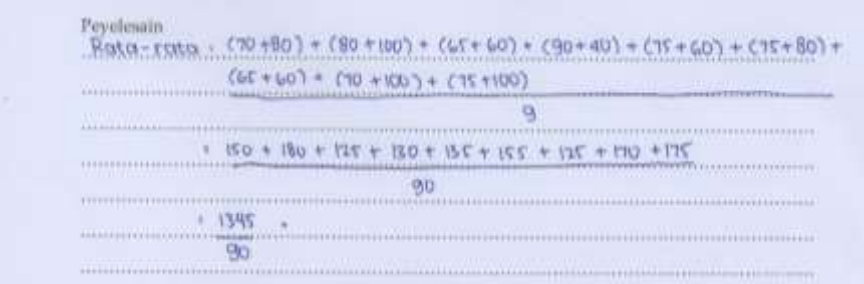

Figure 6. The Solution Result of Student 3

Figure. 6 describes the results of student 3's completion with a high ability classification. From the picture, it can be concluded that the 3rd student has a significant difference from the previous students. The student answers statistical reasoning problems better than the previous two students, but it is still less precise in solving the problems posed. The student averages all numbers both from test results and interview results. This answer is contrary to the problem posed; namely, there is a requirement that data that meets certain criteria is averaged. In operating the addition, it is correct but stops in the division process. There is also an error in mentioning the divisor data at the second count process stage, namely from 9 to 90. From this solution, it is still not perfect to meet the ability in statistical reasoning. This finding is also evidenced in the results of interviews that have been carried out, with the following results.

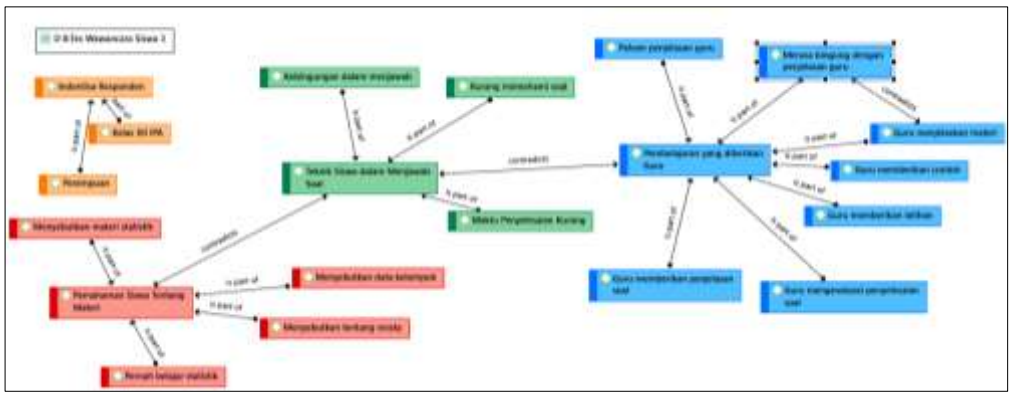

Figure. 7. The Interview Result of Student 3

From Figure 7, the interviews result of student 3. The female respondent then has the same major as the previous respondent. In the statement of technical indicators, the students stated that she does not understand the questions and the completion time was less so she experienced confusion in answering questions. This contradicts the student's understanding of the material, the student can mention that the material discussed in the problem is statistical and average material, even the student states that she has studied statistical material, but misstates that she thinks that the data being studied is group data.

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The teacher's learning indicators also contradict the students' techniques in answering questions. In the teacher's learning indicators, the student explains how the teacher teaches, starting from giving explanation about the material, giving examples of questions, and practicing questions. The teacher also discusses the practice questions answered by the students so that students feel they understand what the teacher is giving. However, there are contradictory statements between the explanations of the material, but students sometimes feel confused by what the teacher explains.

In this study, three respondents were taken on the advice of local teachers who met the classification of the high, medium, and low on statistical reasoning. The selected respondents also previously received statistical material from local teachers. Three respondents came from the science department who had an average mathematical quality higher than other majors. Three respondents were previously given statistical reasoning problems with the indicator "using statistical reasoning in solving daily life problems related to bar charts and data center measures". Three respondents were given 15 minutes to answer the questions provided that they were not allowed to use any tools and were not allowed to discuss with each other. After completing the questions, the respondents were interviewed with indicator guidelines, including students' understanding of the material, students' techniques in answering questions, and learning given by the teacher. The results of the three respondents in answering the problem solving were still very inadequate. None of the three students responded correctly and correctly. The results of the interviews were the same; namely, there was a contradiction between the technical indicators of students in answering questions and other indicators, namely understanding the material and learning provided by the teacher. In the indicators of understanding the material and learning provided by the teacher, the three respondents stated that they understood the statistical material and followed the teacher's explanation. The interview results also identified that teachers still use conventional methods where teachers only discuss the material, provide practice questions, and discuss the questions given.

CONCLUSION

Statistical reasoning is needed to prepare a wise generation in concluding data. The students must have good statistical reasoning skills to face a more complex digital era. Statistical reasoning ability is the ability of students to solve problems using several stages, namely, "Why" to understand statistical concepts and rules, and express reasons for data, "How" to

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provide alternative solutions based on statistical concepts and processes, and "Explain" to draw conclusions based on statistical concepts, rules, and processes. But in fact, the students still need to help and provide solutions by the teacher to improve their statistical reasoning. The field study results show that from an emic point of view, students still need confidence in solving statistical problems; doubt, rushing, and not being careful have a negative impact when students answer statistical reasoning problems. Meanwhile, in terms of ethics, from the interviews, it was generalized that teachers still use conventional methods, so it becomes one of the causes of hampering students' statistical reasoning.

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