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Profile of Student' Concept Understanding of Data Centering and Distribution Measures: A Study on Basic Statistics Course

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Abstract: This study aims to describe the profile of students' concept understanding of data concentration and distribution measures in the Basic Statistics course. The main focus of the research covers students' understanding of the concepts of mean, median, mode, range, variance, and standard deviation. This study used a descriptive qualitative approach involving nine students in the fourth semester mathematics education study program at STKIP Modern Ngawi who had taken the material. Data collection was carried out through open description dianostic tests and semi-structured interviews. Data analysis was carried out using data reduction techniques, data presentation and conclusion drawing based on the Miles and Huberman model, as well as data triangulation to increase validity. The results showed that students in the high category were able to solve problems correctly and provide good conceptual explanations. Medium category students can solve problems procedurally but do not understand the meaning of the concept thoroughly, while low category students show misconceptions and conceptual errors that are quite dominant. These findings indicate the importance of a learning approach that emphasizes not only procedures, but also conceptual understanding and contextual linkages

Keywords: Concept Understanding, Data Centering Measures, Basic Statistics

Abstrak: Penelitian ini bertujuan untuk menggambarkan profil pemahaman konsep siswa terhadap ukuran konsentrasi dan distribusi data dalam mata kuliah Statistik Dasar. Fokus utama penelitian ini mencakup pemahaman siswa terhadap konsep rata-rata, median, modus, rentang, varians, dan simpangan baku. Penelitian ini menggunakan pendekatan kualitatif deskriptif yang melibatkan sembilan mahasiswa program studi Pendidikan Matematika semester empat di STKIP Modern Ngawi yang telah mengikuti materi tersebut. Pengumpulan data dilakukan melalui tes diagnostik deskriptif terbuka dan wawancara semi-terstruktur. Analisis data dilakukan menggunakan teknik reduksi data, penyajian data, dan penarikan kesimpulan berdasarkan model Miles dan Huberman, serta triangulasi data untuk meningkatkan validitas. Hasil menunjukkan bahwa mahasiswa kategori tinggi mampu menyelesaikan soal dengan benar dan memberikan penjelasan konseptual yang baik. Mahasiswa kategori menengah dapat menyelesaikan soal secara prosedural namun tidak memahami makna konsep secara mendalam, sementara mahasiswa kategori rendah menunjukkan kesalahpahaman dan kesalahan konseptual yang cukup dominan. Temuan ini menunjukkan pentingnya pendekatan pembelajaran yang tidak hanya menekankan prosedur, tetapi juga pemahaman konseptual dan hubungan kontekstual.

Kata kunci: Pemahaman Konseptual, Pemusatan Data, Statistika Dasar

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INTRODUCTION

Statistics is one of the branches of science that is very important in various scientific disciplines, especially in processing, analyzing, and making decisions logically and systematically. Statistics has an important role in the data analysis process (Salim & Haidir, 2019). Basic statistics is one of the courses to provide basic understanding and skills in processing, presenting, and analyzing data in preparation for research practice in a thesis. One of the subjects in basic statistics is the measure of data concentration (mean, median, and mode) and the measure of data distribution (range, variance, and standard deviation). Mastery of these concepts is the basis for understanding data distribution, interpreting results, and drawing conclusions in various contexts (Maysani & Pujiastuti, 2020; Anggraheni et al., 20s23).

However, various studies show that students lack understanding of basic statistical concepts. Students have a tendency to memorize formulas and follow existing procedures without understanding the meaning and conditions of their proper use (Amdar et al., 2023). Such as errors in distinguishing when to use the mean or median in data with outliers, or not being able to explain the meaning of standard deviation as a measure of data spread. Most students only rely on pre-calculation procedures without understanding the basic concepts. This shows that students' understanding is still procedural, not reaching a deep conceptual level (Sutrisno & Murtianto, 2015; Maysani & Pujiastuti, 2020; Anggraheni et al., 2022). In fact, conceptual understanding is an important aspect of statistical literacy, especially in the era of big data and database-based decision making. Weak conceptual understanding can have an impact on the low ability of students to think critically and logically in solving statistical problems. A good understanding of statistics is not only shown by the accuracy of calculations, but being able to interpret and explain the results rationally (Subekti et al., 2016). Therefore, it is necessary to identify and analyze the profile of students' concept understanding in this topic, so that it becomes the basis for designing more effective and efficient learning.

Based on the background that has been described, the problem formulation in this research is *"What is the profile of students' concept understanding of the size of the concentration and distribution of data in the Basic Statistics course?".* This study aims to describe students' concept understanding, as well as identify the types of errors or misconceptions that occur in the material of the size of the concentration and distribution of data. This research is limited to the subject matter of measures of concentration (mean, median, mode) and measures of spread (range, variance, standard deviation) without covering inferential statistics material.

METHODS

This study uses a qualitative descriptive approach with the aim of describing in depth the profile of students' conceptual understanding of the measures of data concentration and distribution in the Basic Statistics course. This approach was chosen because it reveals the thought process, conceptual understanding, and difficulties of students in solving open and conceptual questions (Creswell, 2018). This research was conducted at STKIP Modern Ngawi, the subjects in this study were fourth semester mathematics education study program students who had taken the material on the size of the concentration and distribution of data, with the number of subjects selected purposively as many as 9 students out of 20 students who represented high, medium, and low abilities based on previous assignment and exam scores.

The main instrument was an open-ended diagnostic test that included mean, median, mode, range, variance and standard deviation. This test was designed to show not only numeracy skills, but also understanding of the meaning of concepts in the context of the given problem. In addition to the written test, semi-structured interviews were also conducted with selected subjects from each category to further explore the thought

processes and reasons behind the answers they gave. The data analysis technique refers Miles et al., (2014) including data reduction, data presentation, and conclusion drawing/verification. The analysis process also involved an open coding technique to classify students' answers based on understanding categories: conceptually correct, procedurally incorrect, conceptually incorrect, and no answer.

Data validity uses data triangulation techniques by comparing test and interview results, as well as member checking to ensure interpretation of student understanding. Through this approach, it is expected to provide a comprehensive picture of students' conceptual understanding and provide input in improving Basic Statistics learning.

RESULT AND DISCUSSION

This study examines students' conceptual understanding of data concentration and distribution measures including mean, median, mode, range, variance, and standard deviation. Students' understanding is analyzed based on the results of diacnostic tests and interviews. Students were grouped into three ability categories: high, medium, and low, based on their previous exam assignment scores. Determination of students' understanding profile was done by considering the accuracy of answers, the completeness of procedures, and the ability to explain the meaning of concepts verbally and in writing.

Table 1. *Description of Comprehension Profile Based on Ability Category*

Student Category	General Characteristics of Understanding
High	Able to work on problems correctly, show conceptual understanding, and can explain the meaning of statistics appropriately.
Medium	Able to solve problems procedurally, but unable to explain the meaning of concepts and the meaning of results.
low	Shows misconceptions, incorrect procedures, and does not understand the basic concepts of statistical measures.

The high category shows the ability to transfer statistical understanding into real situations, in line with the findings of Garfield (2002) which states that statistical understanding is not only measured and the results of calculations, but also from reasoning about the meaning of the data. While the medium category is only able to follow the existing procedures by looking at the formula without knowing the meaning of the process that has been done. While the low category is unable to solve problems based on existing procedures and does not understand existing concepts so that misconceptions occur in solving problems.

Based on the test results of nine students, each student was recapitulated for each indicator.

Table 2. *Student Diagnostic Test Results Based on Indicators*

Code	Category	Mean	Median	Mode	Range	Variance	Standard Deviation
M1	High	*	*	*	*	*	**
M2	High	*	*	*	**	*	*
M3	High	*	*	*	*	**	*
M4	Medium	*	**	*	**	***	***
M5	Medium	**	*	**	***	***	***
M6	Medium	*	*	**	**	***	***
M7	Low	**	***	**	***	-	-
M8	Low	***	***	***	-	-	-
M9	Low	-	**	-	-	***	***

Keterangan:

* : Conceptually Correct

** : Wrong Procedure
*** : Misconceptions
- : No Answer

High category students (M1, M2, M3) showed good ability in solving basic statistics problems. Not only are they able to complete calculations correctly, they are also able to explain coherently the meaning of statistical concepts such as mean, median, and standard deviation. They understand that data centering measures are not just numbers but represent the characteristics of the data distribution as a whole. In the mean indicator, they not only calculate the average but also consider the effect of outliers on the average result. On the concept of standard deviation, students are able to explain that the measure reflects how far the data spreads from the mean value, and are able to relate to real contexts, such as the variance of test score data. When students are asked how to find data with values that are very far from other data (outliers), how to analyze them, whether to keep using the average. Based on student answers M1:

"I first look at whether the data is balanced. If there are extreme values, the average is not representative, so you need to check the median and standard deviation."

The ability of this category of students is in line with the findings of Garfield (2002) which states that understanding statistics should involve statistical reasoning, namely how a person interprets and communicates information from data. They are able to transfer statistical understanding into real situations, such as in analyzing survey data, exam results, or experimental measurements. Deep concept understanding shows the success of meaningful learning, where students do not just memorize formulas, but relate to real-world experiences and contexts (Garfield et al., 2008; Anggraheni & Kismiantini, 2022).

Students in the moderate category (M4, M5, M6) showed limited understanding of procedural aspects. They generally completed the calculation of mean, median, and mode correctly, but had difficulty in providing in-depth explanations related to these concepts. In distributional indicators such as variance and standard deviation, they tend to just copy the formula without understanding the logic and statistical meaning. Students can mention the standard deviation, but cannot explain that the value shows the degree of variance in the data distribution. When students are asked why the standard deviation formula uses the square of the difference between the data and the average. Based on student answer M5:

“I memorized the standard deviation formula, but sometimes I am confused about why it must be squared first and then the root”.

This indicates that moderate category students have not fully reached the level of conceptual understanding, as according to Groth & Bergner (2006), that statistical understanding must include data representation, procedures, and reasoning. This group of students is still in the process of transitioning from memorization to meaningful conceptual understanding.

Low category students (M7, M8, M9) showed very limited understanding, errors made include: procedural errors in the form of incorrect formulas or miscalculations, misconceptions in the form of considering the median as the most frequently occurring value, or variance as the result of subtracting the largest and smallest values, and the inability to answer or guess the answer. When students were asked why they did it wrong, it was not in accordance with the instructions given. Based on the answers of students M7 and M9:

“I think the mode is the same as the average, just the middle”

"Standard deviation is the sum of all data divided by the average"

This shows that low category students have not mastered the basic understanding of descriptive statistics. According to (Zieffler et al., 2008; Sutrisno & Murtianto, 2015; Anggraheni, 2024) misconceptions like this are commonly found when learning emphasizes too much on formulas and memorization, rather than understanding the concepts and meaning of data. Students in this category need pedagogical intervention in the form of problem-based learning and real contexts, to help them build meaning of statistical concepts from concrete experiences.

CONCLUSION

Based on the results of research on nine fourth semester mathematics education students of STKIP Modern Ngawi, it can be concluded that students' conceptual understanding of the size of data concentration and data distribution is still diverse. Students in the high ability category showed a good understanding conceptually and procedurally, and were able to explain the meaning of the calculated statistical measures. Students in the medium category tend to be able to solve problems procedurally but have difficulty in interpreting the meaning of the data. Meanwhile, students in the low category experienced misconceptions and basic errors, especially in measures of dispersion such as variance and standard deviation.

The main problems identified are the dominance of procedural learning, the lack of context integration in problems, and the low use of media or visualization tools in learning statistics. These findings identify the need for improvement in the learning approach of Basic Statistics in order to develop strong conceptual understanding, not just calculation skills. It is hoped that future research can expand the subject and include quantitative data as a complement, or explore problem-solving-based learning interventions to improve students' conceptual understanding in statistics.

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SHORT PROFILE

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