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ANALYSIS OF STUDENT ERRORS IN SOLVING MINIMUM COMPETENCY ASSESSMENT PROBLEMS BASED ON KASTOLAN THEORY

Novita Anggraini[1], Dwi Priyo Utomo [2], Rizal Dian Azmi [3]

[1]University of Muhammadiyah Malang, Jl. Raya Tlogomas No.246, Babatan, Malang, Jawa Timur.
novialn29@email.com
[2]University of Muhammadiyah Malang, Jl. Raya Tlogomas No.246, Babatan, Malang, Jawa Timur.
dwi_priyo@umm.ac.id
[3]University of Muhammadiyah Malang, Jl. Raya Tlogomas No.246, Babatan, Malang, Jawa Timur.
rizaldian@umm.ac.id

ABSTRACT

In studying geometry, it is common for students to make various errors when working on word problems. Although some students understand the example problems, they may be confused and make errors when presented with different questions. This study employed a qualitative descriptive approach to examine the types and causes of errors made by Grade 8 students from a junior high school in Pronojiwo, Indonesia. The study involved 40 students, with six students selected for interviews. Data were collected using descriptions and interviews. The research employed three procedural stages: preparation, implementation, and data analysis. Data analysis involved data reduction, data encoding, and conclusions. The analysis revealed that 23.3% of students made conceptual errors, 27% made procedural errors, and 44.5% made technical errors. The factors contributing to these errors included students' lack of focus on reading the questions, limited understanding of the material, haste in completing the questions, insufficient knowledge of the problems in the questions, and carelessness in checking their answers.

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Corresponding Author

Novita Anggraini
Universitas Muhammadiyah Malang
Jl. Raya Tlogomas No.246, Babatan, Tegalgondo, Kec. Lowokwaru, Malang, Jawa Timur
Email: novialn29@email.com

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INTRODUCTION

Mathematics is considered a crucial subject because it is the foundation of science and technology, with arithmetic and logical reasoning being its core components (Yeh et al., 2019). Therefore, mathematics learning should be designed to engage students and encourage mathematical thinking, problem-solving, and attainment of learning objectives (Muhammad Fajri, 2017; Sukmawati & Amelia, 2020). Mathematical learning aims to develop students' mathematical communication skills and reasoning abilities (Habsah, 2017), which have multifaceted implications for mathematics education (Sukirwan et al., 2018). In this context, the ultimate goal of mathematics education is to foster students' abilities in mathematical communication, reasoning, and problem-solving.

Although one of the objectives of learning mathematics is problem-solving, some students find it difficult to solve mathematical problems (Hidajat, 2018). Mathematical errors refer to those pervasive errors that students make based on the difficulties they have experienced when dealing with mathematical problems (Iswara et al., 2022). Errors made by students in doing problems result in the low acquisition of learning outcomes for each student when participating in the mathematics learning process (Fitry et al., 2022). Error is a deviation from a correct and structured answer (Mubarok et al., 2017). Systematic and consistent errors result from students' lack of mastery and perception of the material studied (Melisari et al., 2020). Meanwhile, incidental errors are caused by not being careful in understanding the meaning of the problems, calculating, and haste when doing them (Rangkuti, 2020).

Student errors when doing math problems lead to low literacy ability of numeracy in Indonesia (Fitry et al., 2022), as confirmed by the results of the 2018 PISA test, where Indonesia was ranked 72 out of 77 countries (Fazzilah et al., 2020). The difficulty of students in doing Higher Order Thinking Skills (HOTS) problems in the National Exam (UN) is one of the consequences of the lack of ability to think critically and reason (Sani, 2021). This resulted in the enactment of a Minimum Competency Assessment (known as AKM) by the Ministry of Education and Culture to improve literacy and numeracy in Indonesia (Yusuf & Ratnaningsih, 2022). Ratna Sari (2021)) in her research, stated that numeracy skills in doing AKM questions are relatively low. This statement is also supported by Arofa & Ismail (2022) revealed that many students have low numeracy skills. They found that out of 36 students, 23 were with low-level numeracy ability, 12 were with medium-level numeracy ability, and one had highlevel numeracy ability.

One approach to evaluating students' problem-solving errors is by applying various theoretical frameworks, such as the Kastolan theory. This theory identifies three types of errors that students may make when solving problems: conceptual, procedural, and technical errors (Ulfa & Kartini, 2021). Utilizing the Kastolan theory can assist researchers in pinpointing the specific nature and location of students' errors when working on AKM problems.

This study differs from the research conducted by Raharti & Yunianta (2020) in several ways. First, this study utilized plane geometry as the subject matter, while the previous research focused on the System of Linear Equations in Two Variables (SLETV). Second, this study only selected a few subjects who made the most errors in the interviews. In contrast, the previous study included several subjects based on their math scores and willingness to participate in the research. Finally, in the previous study, scaffolding was provided to the research subjects, while this study did not provide any scaffolding.

Based on the information provided by a mathematics teacher at one of the junior high schools, students often make various errors when solving geometry word problems. Although some students comprehended the sample problems, they were confused when solving different problems. Consequently, they made errors while solving the problem. However, the exact location of students' errors in solving geometry word problems remains unknown to the teachers.

Hence, it is necessary to conduct a study on the errors made by students to evaluate them and help teachers address the difficulties students face while solving problems and achieving the objectives of learning mathematics. The research question of this present study is 'What are the percentage of errors and the causes of errors according to the type of error? This study aimed to provide a descriptive analysis of the percentage and causes of errors based on the Kastolan theory.

METHODS

This research is a descriptive study using a qualitative approach that aims to determine student error types. The research subjects were 40 Year 8 students selected to participate in AKM, with six as representatives for the interviews. The six students were those who made the most errors. The error analysis was done by referring to the Kastolan error stages. The errors were identified by looking at students' steps to solve the problems. The indicators of errors that the researchers developed corresponded to Kastolan's analysis, as seen in Table 1.

Table1. Kastolan Error Indicator

Types of Errors	**Indicator**
Conceptual error	Unable to interpret the problem/use a term, concept, and principle
	Unable to select formulas/properties accurately
	Unable to apply formulas/properties accurately
Procedural errors	Inequality of steps of resolution with the question in question
	Unable to solve the problem until the final stage
Technical errors	Error on count operation
	Error in moving count or number operations from one step to another

Source : (Ulfa & Kartini, 2021)

Data collection was done through tests and interviews. The test consists of three long-answer problems. The indicators in the questions were as follows: 1) Given an illustration of making a hat, students determine the area of a semicircle, 2) Given an illustration of making an ideal house, students determine the area of the ideal house land, 3) Given an illustration of the land for the house, students determine the circumference of the land. Interviews were conducted every day after the students took the test. The interview subjects were selected based on those who made the most error on each error indicator. The interview guide used the constraints of the error indicator. The test questions and interviews used have been validated by the mathematics education lecturer, with the results of the test questions being suitable for use.

The data analysis technique involved data reduction, data presentation, and conclusion. The data reduction stages included: 1) The researchers collected the data in the implementation procedure, 2) The data was the student's answers, 3) The research results of the student's test were scored based on the answer key, the researchers removed the students with high scores because this study focused on student errors, 4) the results of the interviews were simplified. Data was then presented in narrative form; the data presented was the reduced data, containing information about student errors. Conclusions were drawn by concluding the data obtained and the data analyzed in the study.

RESULT AND DISCUSSION

The presentation of results of research on the errors made by students in solving the

AKM problems using Kastolan theory is presented in this section. In the implementation, researchers analyzed the student's answers. Table 2 presents the percentage of students errors.

Table2. Student Error Percentage

Error Type	The Errors in Each Problem			Sum	Percentage
	Problem 1	Problem 2	Problem 3		
Conceptual	18	22	44	84	$\frac{84}{360} \times 100\% = 23{,}3\%$
Procedural	10	13	44	67	$\frac{67}{240} \times 100\% = 27{,}9\%$
Technical	36	27	44	107	$\frac{107}{240} \times 100\% = 44{,}5\%$

Conceptual Error

Table 2 shows that the percentage of conceptual errors is 23.3%. Further analysis revealed that most conceptual errors occurred in Problem 3, where students had difficulties entering the values from the length of the parallel sides. For instance, Subject S1 made conceptual errors in all three indicators of conceptual errors in Problem 1, as illustrated in Figure 1.

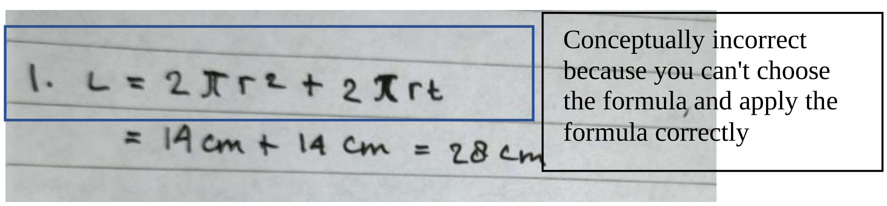

Figure 1. An Example of Conceptual Error

Based on the answer sheet of the S1 student, one of the errors made was an error in choosing the formula. The student was less thorough when reading the problem. In Problem 1, the question was the area of the semicircle paper cap; students could do the problem using the formula $\frac{L\ lingkaran}{2} = \frac{\pi \times r^2}{2}$. However, S1 students use the formula of tube surface area, resulting in an incorrect solution.

Conceptual errors occur when students misinterpret the question, inaccurately write, or incorrectly apply formulas. Factors contributing to conceptual errors include a lack of focus on reading the questions, inadequate understanding of the material, and feeling rushed to complete the problems.

Procedural Errors

The percentage of students' procedural errors is 27.9%. In Problem 3, most students made procedural errors, with indicators of being unable to solve the problem in the final stage.

Most students only looked for one of the parallel side lengths in a trapezoid. Figure 2 represents one of the students' procedural errors.

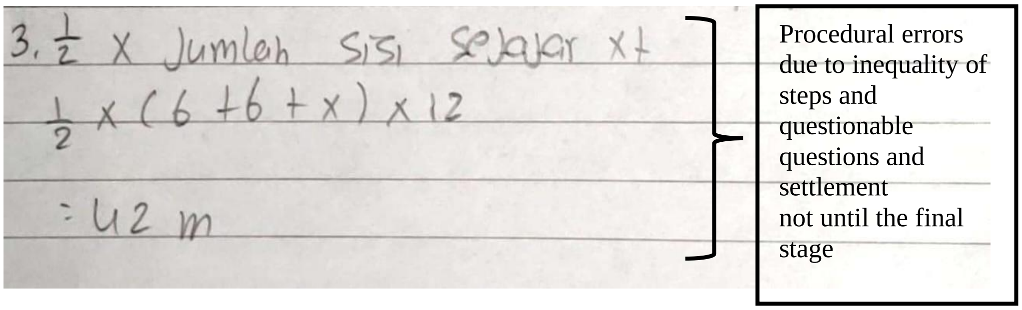

Figure 1 An Example of Procedural Error

Based on the answer sheet of S3 students, one of the errors made was not being able to solve the problems until the final stage. The student only did the problem until entering the value into the trapezoidal area formula. The solution to Problem 3 should require three stages: finding the value of x the parallel side obtained from the area of the trapezoid, looking for the hypotenuse of the triangle, and looking for the circumference of the trapezoid. However, S3 students only found the value x from the parallel side and were unsuccessful, resulting in incorrect answers. Students make errors when they are unable to do until the final stage. The factor causing students to make procedural errors is that students are too hasty in doing the questions and do not understand the problems.

Technical Errors

The percentage of students' technical errors is 44.5%. The analysis of students' answers shows that many students made technical errors in Problem 3. Figure 3 displays one of the students' answers with technical errors.

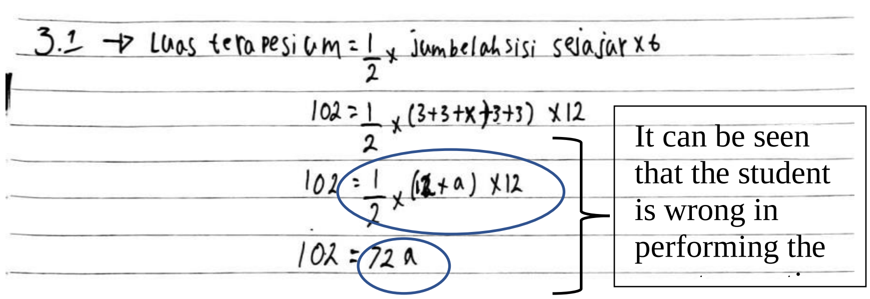

Figure 2. An Example of Technical Error

Figure 3 shows that S6 students made technical errors where students were wrong when calculating $\frac{1}{2} \times (12 \times a) \times 12$, which should $(12 + a) \times 6 = 72 + 6a$ have been, but S6 students wrote $72a$. Another error made by S6 students was in moving x. S6 student moved a, which should x. It can be seen from students making errors in counting. Technical errors are the most common among students and are caused by factors such as carelessness during the calculation process, hasty or incomplete answers, and the consequences of previous errors.

The results of this study revealed that most students made technical errors. This finding contrasts the research of Ayuningsih et al. (2020), where technical errors are the least. Technical errors are caused by students lacking accuracy in solving problems and not checking the results of their work, resulting in incomplete solutions. This finding is consistent with the study conducted by Raharti and Yunianta (2020), which identified several factors contributing to technical errors, such as students' lack of carefulness in calculating and checking their answers, the tendency to rush through problem-solving, and inattention to details. External factors could also influence these technical errors, such as time constraints imposed during the problem-solving process.

CONCLUSION

This study found that students made errors in three types of errors: conceptual errors (23.3%), procedural errors (27.9%), and technical errors (44.5%). Conceptual errors were indicated by students' inability to interpret the problem, choose the formula accurately, and apply the formula accurately. Procedural errors were marked by students' failure to solve the problem until the final stage. Errors in the calculation process indicated technical errors. Factors contributing to these errors included lack of focus on reading the questions, lack of understanding of the material, haste in completing the questions, lack of familiarity with the problems in the questions, and failure to check answers carefully.

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