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KASTOLAN THEORY ERROR ANALYSIS ON VOCATIONAL SCHOOL STUDENTS – A CASE ON SEQUENCES AND SERIES TOPICS

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ABSTRACT

The purpose of this study is to analyze the mistakes made by students while working on math problems in Sequence and series. The background to this study is that it is difficult to understand students during their studies, which leads to mistakes in solving the math problems of Sequence and series. The purpose of this study is to determine what mistakes are common in solving questions about Sequence and series. The subjects of this study were 10 students of eleventh grade at SMK Plus Darussurur, Cimahi City. The data collection method uses written essay questions with results obtained from the analysis of the level of error based on the Kastolan Theory. Based on the results of the research and discussion, it was found that the level of student errors in working on sequence and series problems is as follows : 1) Conceptual errors with a percentage rate of 50% with the criterion of "High Enough" error rate; 2) Procedural Errors with a percentage rate of 32.1% with the criterion of "Low" error rate; 3) Technical errors with a percentage of 17.9% with the "Very Low" error rate criterion. From this, we can conclude that the common error in solving the Sequence and seriesproblem is a form of conceptual error. This means that the students' conceptual understanding of Sequence and series is still lacking. Because learning tends to focus on procedures without linking basic concepts, lack of visualization and real context, and limited abstract thinking skills and varied exercises.

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INTRODUCTION

Mathematics is a very broad science that covers almost all aspects of life. Carraher (2008) argues that Mathematics has made important contributions to long-standing debates about mathematical concepts, symbolic representation, and the role of context in thinking. According to Novtiar & Aripin (2017) Mathematics is a science that is based on the thought process. Marlina et al., (2018) state that teaching mathematics to students is necessary for the following reasons: (1) widely used in various walks of life; (2) requires mathematical skills, suitable for all walks of life; (3) concise, reliable and easy to understand communication tools

are needed; (4) presentation of data in various models; (5) development of logical and thorough thinking; (6) a sense of satisfaction when solving a problem.

Another thing that Soedjadi (2015) is that the characteristics of mathematics are that its objects are abstract, conventional, pay attention to deduction, have signs without meaning, pay attention to the universality of discourse, and are consistent in their formulas. Abstract mathematical objects consist of facts, concepts, operations, and principles. (Lexi, 2015) These abstract mathematical objects can be observed when someone is solving or has solved mathematical problems.

As stated by Vivi (2019) said Conceptual understanding is one of the mathematical skills or abilities that are expected to be achieved in learning mathematics. Mathematical conceptual understanding will be meaningful if mathematics learning is directed at developing mathematical connection skills between various ideas, understanding how mathematical ideas are related to each other so that a comprehensive understanding is built, and using mathematics in contexts outside of mathematics.

As stated by Laeli, H (2017) However, in Indonesia, there are still many students who have difficulty in understanding basic mathematical concepts thoroughly. This can be seen from the tendency of students to only memorize formulas without really understanding their meaning and application in real contexts. As a result, students often have difficulty when faced with questions that require reasoning or application of concepts in different situations. so that students experience many errors in solving problems. Mc.Laren, et al (2012) stated that Error analysis is an instructional strategy that holds promise of helping students to retain their learning. Mc.Laren, et al (2012) too, Error analysis consists of being presented a problem statement with the steps taken to reach a solution in which one or more of the steps are incorrect, often called erroneous examples.

Difficulties in learning mathematics have their own differences compared to other learning, such as difficulty in distinguishing numbers and mathematical symbols and inability to memorize mathematical sentences. (Ratnasari & Setiawan, 2007). For example, in the material of Rows and Rows in class XI SMK, this material is material that races on calculations in concept understanding. In this material there are also frequent errors. When viewed from the completion of this material looks easy, but many students also have difficulty in trying to work on Rows and Sequence problems. This is because this material has its own concepts, so students must first understand the concepts in this material. If students have a good understanding of the concepts in this material, when students find different problems when discussed together with the same concept, students will be able to work on these problems. If students do not know the concept, then students cannot solve problems related to arithmetic. A lot of students think that row and sequence material is difficult because it takes more time to find the concept or pattern of a number than to calculate it.

The discussion in this article aims to analyze errors in solving Row and Sequence problems. Wijaya and Masriyah (2011) suggest that an error is something that deviates from what has been considered correct, or how to deviate from the applicable procedures or steps. There are many kinds of errors in learning mathematics. There are 3 categories of errors according to Kiat (2005), namely: 1) Concept errors, namely errors caused by not understanding the concepts that are arranged in a problem. 2) Procedural errors, which are errors caused by the lack of or even not following previously established procedures. 3) Technical errors are errors caused by ignorance or negligence.

D.P. Arum, et al (2018) stated Conceptual errors occur when students fail to understand the concepts that will be used in the problem-solving process. Concept errors here are based on

the story problems that are made. Students tend to lack understanding of the concepts in story-shaped problems where when the concept of the problem is explained, students only understand and can do the problem well. Procedural errors occur when students ignore the steps of problem solving (Mylopoulos, et al 2018). The procedural errors in this study are in the form of inaccurate procedures for solving problems in this material, such as missing steps that result in completely wrong answers. As for the last, technical errors in this study when the concept and procedure are correct but students still make mistakes in calc ulating the final amount in solving the problem. In other words, students' negligence in calculating the answer. Technical errors are crucial in the problem-solving process as they lie in the students' basic ability to solve the problem (A. C. Graesser et al, 2018). Technical errors are often found in students who do not understand the previous material (Y. Weinstein et al, 2018)

The result of this research is a count of how many student errors based on concept errors, procedural errors and technical errors. Based on these errors, the researcher will calculate the percentage of each type of error. How many percent of concept errors were made, how many percent of procedural errors were made, and how many percent of technical errors were made. Then the types of student mistakes will be analyzed and described based on student results.

METHOD

Descriptive qualitative method was used in processing data in the study. Descriptive qualitative is collecting data from test score data, which is then analyzed what mistakes students make in solving problems, especially regarding the sequence and series of material, then calculating the percentage for each type of error.

The subjects of this study were 10 students of class XI OTKP from SMK Plus Darussurur Cimahi which was conducted in the even semester of the 2022-2023 school year. The instrument is in the form of 5 story problems on Arithmetic and Geometric Rows and Sequences material. Indicators in the form of questions used to examine the results of student errors when solving the problem of rows and series, can be seen in the table:

Table 1. Question Indicator

No	Competency Achievement Indicators (IPK)	Questions
1.	Explain number patterns, Arithmetic Rows and Sequences	Observe the following number sequence! (i). 1, 3, 5, 7, 9 (ii). 4, 6, 9, 13, 18 (iii). 3, 6, 12, 24, 48 Which of the above numbers are Arithmetic Rows? Tell us the reason!
2.	Determine the nth term in the arithmetic sequence	3, 7, 11, … What is the 10th term?
3.	Calculate the sum of an arithmetic sequence	The 2nd and 8th terms in an arithmetic sequence are 15 and 45 respectively. What is the 15th term in the above arithmetic sequence?
4.	Calculating the value of a term in a Geometric Line	A piece of rope will be divided into 5 parts, which form a 5-number geometric line. If the first rope is 20cm long and the ratio of each rope is 2x. What is the length of the original rope?
5.	Find the n-th number of terms in a	Amoeba will divide itself into 2 every 5

No	Competency Achievement Indicators (IPK)	Questions
	Geometric Line	minutes. If there were 5 amoebas at the beginning, how many will there be in 1.5 hours?

Then the mistakes when working on the 5 questions above will be used as material for analysis based on concept, procedure and technical errors. Then it will be calculated how many percent in each type of student error as evidence that students understand the material during learning or not.

The steps in analyzing the data above are as follows: 1) checking and correcting student work; 2) analyzing and classifying what mistakes students make (based on concept, procedure and technical errors); 3) calculating the percentage value of the type of error for each item; 4) the results of data calculation will be processed in descriptions; 5) drawing conclusions.

o calculate the percentage of errors using the formula:

$$P\text{x} = \frac{nx}{N} \times 100\%$$

Dengan : Px = Percentage of category x error

nx = Number of category x errors on all questions

N = Total errors in all categories

After calculating the percentage of the type of error, it is then converted based on the Student Error Criteria Table.

Table 2. Student Error Criteria

No	Persentase	Criteria
1.	0 % < x > 20 %	Extremely Low
2.	20 % < x > 40 %	Low
3.	40 % < x > 60 %	Quite High
4.	60 % < x > 80 %	High
5.	80 % < x > 100 %	Extremely High

RESULTS AND DISCUSSION

Results

In this investigation was conducted by giving a test in the form of 5 problems of Rows and Rows to 10 students. The day the results of each error were observed, 26 students made 28 errors with details of each problem and the type of error as follows:

Table 3. Recapitulation of Errors on Each Problem

Error Type	Number				
	No. 1	No. 2	No. 3	No. 4	No. 5
Concept	2	1	4	3	4
Procedure	-	-	3	4	2
Technical	-	-	2	2	1

Based on the table above, the data is obtained in the form of:

1. Total of 14 student questions made concept errors with a percentage rate of 50% with the error rate criterion “Quite High”

2. Total of 9 student questions made procedural errors with a percentage of 32% with the error rate criterion "Low"
3. Total of 5 student questions made technical errors with a percentage of 18% with the error rate criterion "Very Low"

The data above can be presented in the form of the following diagram:

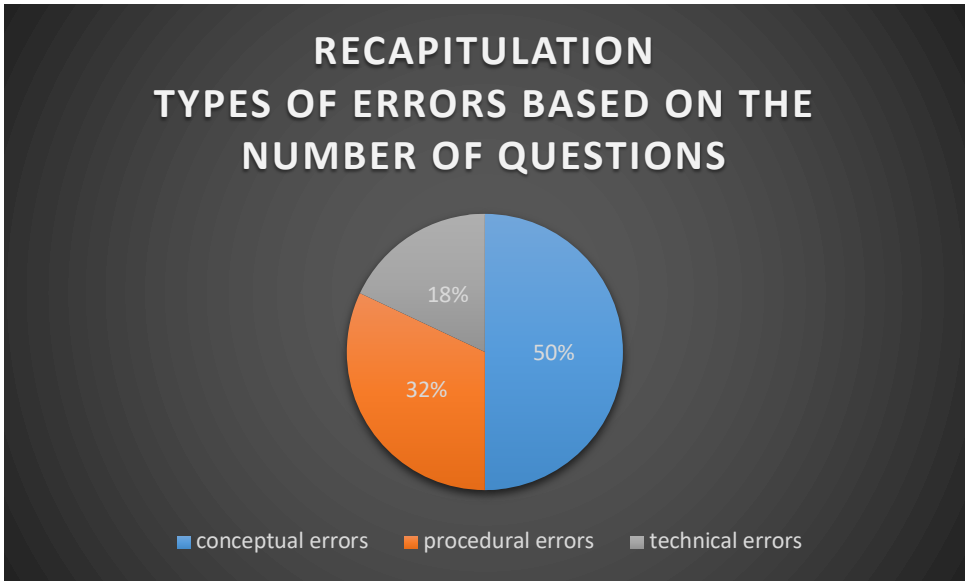

Figure 1. Student Error Percentage Diagram

Students made 28 errors when working on rows and series problems with the following types of errors and explanations:

1. Consept Error

Total of 14 questions students made concept errors with the error rate criterion "Quite High". Conceptual errors here occur because students do not understand the concepts and problems in the problem. The types of questions that dominate conceptual errors include questions no. 4 and no. 5.

In problem number 4, students are asked to calculate the length of the longest piece of rope in a geometric line formed from 5 pieces of rope. Most students do not understand the concept in this problem. Where the concept is, if the rope is cut into 5 parts, it means that there are 4 figures that form a geometric row. The shortest piece of rope is the first term, the longest piece of rope is the 5th term of the row and the ratio is 2 times. Thus this problem can be solved by calculating the sum of the first 5 terms of the geometric sequence using the geometric sequence formula discussed in the previous lesson. Illustrated in problem number 4 which is done by one of the students:

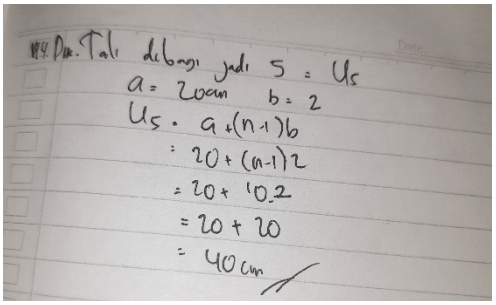

Figure 2. Result Problem Number 4

Almost similar to problem number 5, students are asked to determine the number of amoebas at 1.5 hours after the number increases every 5 minutes. Students have difficulty understanding the concept in problem number 5. Where the concept is that the number of amoebas doubles every 5 minutes. Therefore, what must be done is only to calculate the number of amoebas every 5 minutes, using the geometric sequence formula discussed in the lesson. However, because students did not understand the problem well, there were errors when filling out the problem. Illustrated problem number 5 which was done by one of the students:

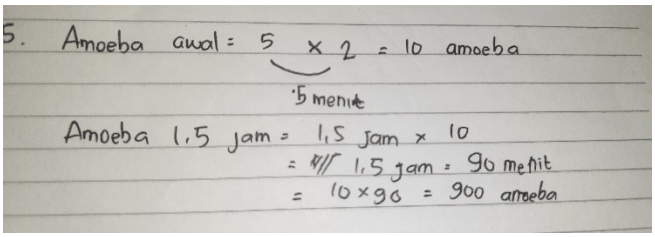

Figure 3. Result Problem Number 5

2. Procedure Error

Total of 9 questions students made procedural errors with the error rate criterion "Low". Procedural errors here are due to missing or incorrect steps as well as some procedures that are not completed by students. The type of problem that dominates procedural errors is one of them in problem number 3.

In problem number 3 students are asked to determine the 15th term of 2 known terms. Students have difficulty working on this problem because first students have to find the first term and the difference in the 2 lines. Most students do not understand and miss the way to determine the first term and its difference, therefore there are errors in filling out the problem. Illustrated problem number 3 which was done by student A:

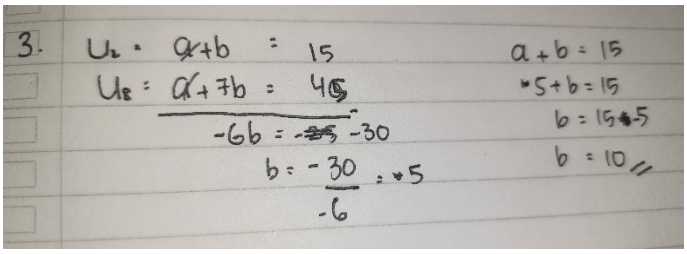

Figure 4. Result Problem Number 3

3. Technical Error

Total of 5 questions students made technical errors with the error rate criterion "Very Low". There are no questions that dominate technical errors because technical errors here are made due to lack of accuracy or carelessness of students in calculating.

Discussion

From the results of observations on student results, students make various kinds of mistakes in solving math problems. Zebua et al., (2020) stated that the factors that cause students to make these mistakes are the lack of student readiness in following the learning process, lack of concentration in working on questions, being less careful, forgetting the formula and lack of student understanding of the sequence and series material. This is also in line with the results of the study. Hasibuan et al., (2021) which states that the factors that cause students to give wrong answers when solving Math Problems in general include: 1) Students lack the process of understanding the problems they get, which causes students to be confused when

completing their answers; 2) Lack of student accuracy when calculating answers results in the final process of the answer being wrong; 3) Students are unable to change the form of the problem into a mathematical model; 4) Students do not yet know the sequence in the process of solving problems. Back to the main discussion of the research, students' errors in solving problems based on Kastolan's theory are of 3 types: 1) Conceptual Errors; 2) Procedural Errors; 3) Technical Errors.

Conceptual errors here occur because students do not understand the concept and problems in the questions, students do not know what the main problem is that occurs so that students have difficulty in solving the questions. This is in line with research Debi et al., (2021) which states that the factors that cause students to make conceptual errors are that students do not understand the prerequisite material and students' minimal knowledge regarding the use of the elimination method and substitution method. This is also because students do not understand what is ordered in the question. It is also mentioned in another study from Ayuningsih (2020) that errors were found that were categorized as types of conceptual errors, namely: a) student errors when identifying a question that has been obtained, b) student errors in identifying data, c) student errors in identifying what is asked in the question, d) student errors when using a concept in the form of variables, and e) student errors when creating a mathematical model according to the given question

Procedural errors here are due to missing or incorrect steps and some procedures that are not completed by students. This is in line with research Purwati & Nugroho (2015) where procedural errors occur because students are wrong in choosing and arranging steps in solving problems. Also in line with research from Ulfa & Kartini (2021) procedural errors made by students are characterized by students still not mastering each step in solving up to the final solution or the simplest form.

Technical errors here are made due to the lack of accuracy or carelessness of students in calculating. Only a few of the many students make technical errors because some of the students are not careful and recheck the results of their answers. This is in line with research Hasibuan et al., (2022) which states that the lack of accuracy of students when calculating answers results in the final process of the answer being wrong. The lack of students' ability to perform arithmetic operations can be a factor causing students to be unable to complete the results of the answers. (Fujirahayu et al., 2022)

CONCLUTION

The results of the discussion have been analyzed with what errors students make in finding problems and solving problems based on the types of concept, procedure, and technical errors. The most common error found is concept error. with a percentage of 50% for the error rate criterion “quite high”. And the least technical errors were made with a percentage of 18% of the criteria with a “very low” error rate. caused by a lack of understanding of the concept of the problem in the problem, as well as a lack of mastery of content and material during learning. Meanwhile, technical errors have nothing to do with learning outcomes, but technical errors here are made due to students' lack of accuracy in calculating and working on problems.

One of the factors causing students' lack of conceptual understanding in solving sequence and series problems is a learning approach that focuses too much on the use of formulas and procedural steps without providing an in-depth explanation of the basic concepts behind the material. This makes students just memorize without really understanding the meaning of each process carried out. In addition, the minimal use of visual media, illustrations, or relevant real-life contexts makes the concept of sequences and series feel abstract and difficult for students to understand. The limitations of abstract thinking skills that have not fully

developed in some students are also obstacles in understanding number patterns and regularities. In addition, the lack of variation in practice questions and the absence of a reflection process on mistakes made mean that students do not have the opportunity to improve and deepen their understanding.

Teachers must develop other strategies so that the material can be understood by students thoroughly. Among them, an approach that is appropriate to the material can overcome these problems, also supported by devices that support learning. Teachers must find an appropriate approach so that the material is delivered well based on the steps listed in the approach. In addition, other supporting devices can help teachers in providing material to students, such as teaching aids to support the delivery of material well, additional teaching materials, and so on. With this, it is hoped that students can understand the learning well so that problems when working on questions can be solved properly.

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