Students' errors in solving math problems in the form of stories on the topic of sequences and series

Muhammad Yusup[1*]
[1*]Mathematics Education Teacher, SMP Tarbiyatul Aulad 2, West Java, Indonesia
[1*]muhammadyusup@gmail.com

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Abstract
This study investigates the common errors made by students when solving math problems presented as story problems, specifically within the topic of sequences and series. Utilizing a qualitative descriptive approach, the research analyzes the types and frequencies of errors encountered by students, aiming to identify underlying misconceptions and gaps in understanding. Data were collected from a sample of Smk Tarbiyatul Aulad Cikajang students through written tests and follow-up interviews. The results reveal that students often struggle with interpreting the narrative of story problems, translating real-world scenarios into mathematical expressions, and applying the correct formulas for sequences and series. Additionally, the study highlights the impact of poor problem-solving strategies and insufficient practice in dealing with contextual math problems. These findings underscore the need for targeted instructional interventions that address specific misconceptions and enhance students' ability to tackle story problems effectively in the context of sequences and series.
Keywords: students' errors; math problems; stories problem; sequences and series

Abstrak
Studi ini menyelidiki kesalahan umum yang dilakukan siswa saat memecahkan soal matematika yang disajikan sebagai soal cerita, khususnya dalam barisan dan deret. Dengan menggunakan pendekatan deskriptif kualitatif, penelitian ini menganalisis jenis dan frekuensi kesalahan yang dialami siswa, yang bertujuan untuk mengidentifikasi kesalahpahaman dan kesenjangan pemahaman yang mendasarinya. Data dikumpulkan dari sampel siswa Smk Tarbiyatul Aulad Cikajang melalui tes tertulis dan wawancara lanjutan. Hasilnya mengungkapkan bahwa siswa sering kali kesulitan menafsirkan narasi soal cerita, menerjemahkan skenario dunia nyata ke dalam ekspresi matematika, dan menerapkan rumus yang benar untuk barisan dan deret. Selain itu, penelitian ini menyoroti dampak dari strategi pemecahan masalah yang buruk dan praktik yang tidak memadai dalam menangani soal matematika kontekstual. Temuan ini menggarisbawahi perlunya intervensi instruksional yang ditargetkan yang mengatasi kesalahpahaman tertentu dan meningkatkan kemampuan siswa untuk menyelesaikan soal cerita secara efektif dalam konteks barisan dan deret.
Kata Kunci: analisis kesalahan; permasalahan matematika; soal cerita; barisan dan deret

Introduction

Mathematics lessons need to be given early to students to equip them with creative thinking, reasoning, and hard work. But in reality, there are still many students who think that mathematics is difficult. One of them is in solving story-based math problems. Story problems are presented in the form of stories and the problems expressed are everyday life problems. Most students find it difficult to understand the meaning of the questions given, what is asked in the questions, and there are still many errors in the calculations. This is because solving story-based math problems requires high levels of understanding and reasoning. There are still many students who do not understand how to translate everyday sentences into mathematical sentences or mathematical models.

Spencer and Spencer define ability as a prominent characteristic of an individual that is related to effective and/or superior performance in a job or situation (Uno, 2006). Thus, students' ability to solve math problems in the form of stories includes several steps of completion, namely the ability to understand problems, create mathematical models, and calculations. If there is an error in one of the steps of the solution, it will cause an error in the next step and result in low results obtained by students in solving math problems in the form of stories.

Arithmetic sequences and series are part of the number sequence material taught in grade XI. The success of students in the material of arithmetic sequences and series is one aspect that is very important and needs to be considered because this material is included in one of the competencies that must be achieved in mathematics learning as stated in Permendikbud Number 21 of 2016, namely explaining and using patterns to make predictions. In addition, the material of arithmetic sequences and series is also one of the materials contained in the National High School Examination grid and the TIMSS content domain (Kemdikbud, 2018; TIMSS & PIRLS, 2015). A good understanding of concepts is one of the factors for student success in the mathematics learning process. Therefore, understanding the concept of the material of sequences and series, one of which is arithmetic sequences and series, is very important to be instilled so that students are able to solve mathematical problems well (Sanjaya et al., 2018).

In Indonesia, there are still many students who have difficulty in learning the material on arithmetic sequences and series. This can be seen from the results of previous studies which found that most students have difficulty in determining the nth term (Un) of an arithmetic sequence. This is because students do not understand the meaning and information given in the question, especially if the question given is a story question about the application of arithmetic sequences and series (Qolbi et al., 2022; Domu & Mangelep, 2020). This is supported by the results of Kreitzer and Sweet-Cushman (2021) study which stated that there are still students who are wrong in determining the value of Un and also

wrong in using the formula for the sum of the nth term because students do not understand the difference between arithmetic sequences and series and geometric sequences and series. In addition, based on the results of interviews conducted by previous researchers (Muthmainnah, 2023) with one of the mathematics teachers at MAN 1 Makasar, it was obtained that most students were only accustomed to memorizing formulas but could not apply them to problems correctly, especially if the problems given were different from the examples. Based on this, it can be concluded that students do not understand the concept of arithmetic sequences and series well.

The learning difficulties and low conceptual understanding experienced by students are caused by several factors, including the availability of teaching materials and the learning model used (Chew & Cerbin, 2021). Currently, the majority of teachers in Indonesia use conventional learning models so that teachers are more dominant in the learning process (teacher-centered) where learning begins with informative material presentation by the teacher, giving examples of questions, and evaluation through practice questions so that students are only accustomed to memorizing formulas and following the steps for solving taught by the teacher procedurally (Saks, Ilves, & Noppel, 2021; Burges et al., 2020). This results in most students assuming that mathematics is just a lesson in calculating numbers and memorizing formulas, and as if mathematics has no meaning and relevance in everyday life, let alone solving problems that occur around them. As a result, student motivation and activeness in learning mathematics tend to be low, even though the motivation and activeness of students themselves can have a positive impact on student success in learning mathematics (Kurniawati, 2017).

In addition to the learning model, the use of inappropriate teaching materials is also one of the factors causing students' learning difficulties, where most of the current mathematics learning is only focused on the use of ready-to-use textbooks (Foster et al., 2021). Meanwhile, the ready-to-use textbooks used to support the mathematics learning process currently still have several shortcomings, including the results of Pepin and Gueudet's research (2020), information was obtained that the government's mathematics textbooks as the main reference books for students still do not show any emphasis in defining mathematical concepts. In addition, the results of research conducted by Andira & Herman (2022) also explained that one of the companion books in Mathematics learning activities published by Erlangga that is currently used has not been able to encourage students to be actively involved in the learning process and also still contains concepts such as theorems and formulas that are presented directly without any process of knowledge formation in students. Meanwhile, it is known that students who construct their understanding of mathematical concepts independently by using a contextual problem will have a better understanding of the concept and the concept will be more embedded in the minds of students compared to students who only receive information directly (Limeri et

al., 2020). Based on this, it is necessary to develop teaching materials for arithmetic sequences and series by applying a student-centered learning model so that it can encourage students to be actively involved in the learning process and actively construct the concepts they are learning independently.

According to (Bukit, 2020), one way that can be used to find out student errors is to conduct an error analysis study. One procedure that can be used to study error analysis is the Newman procedure. The Newman procedure is used in this study because the Newman procedure can be used to analyze student errors in solving descriptive questions. The Newman procedure was first introduced by Anne Newman, a mathematics teacher in Australia in 1977 (McDermott & Newman, 2021). This procedure aims to understand and analyze how students solve a problem through several error steps, namely (1) reading errors; (2) comprehension errors; (3) transformation errors; (4) process skill errors; and (5) encoding errors (Agustiani, 2021).

With the above problems, the author is motivated to conduct research to analyze students' ability to solve math problems in the form of stories. This research is important to be conducted in order to find out students' abilities and what mistakes students make in solving story problems on the topic of sequences and series.

Method

This type of research is qualitative descriptive research. The data collected are in the form of writing, words, or pictures. This research was conducted by Smk Tarbiyatul Aulad Cikajang. The research period was 2 weeks. The subjects in this study were class XI TKJ students consisting of 10 students.

The data collection methods used in this research include: (1) the main method in the form of a test used to collect data which is then processed and analyzed, (2) auxiliary methods in the form of: (a) observation to obtain a picture of the students, (b) interviews to find out about the difficulties experienced by students in working on questions, (c) documentation to obtain data on student names, student registration numbers, and photos.

The validity test of the data in this study was conducted through validity and reliability tests. The test questions were tested to determine the validity and reliability which would later determine whether or not the questions were suitable for use in collecting research data. To test the validity of the question items, the product moment correlation formula (r_{xy}) was used.

After obtaining r_{xy}, it is then consulted with the r product moment table. If $r_{xy} > r_{\text{tabel}}$ then the question item is said to be valid.

An instrument is called reliable if the measurement results with the tool are the same or almost the same. To find the overall reliability of the questions, it is necessary to analyze each question item using the Alpha formula (r_{11}). To determine the reliability of the test questions, the r_{11} value obtained from the Alpha formula is interpreted with the correlation indeks in the Table 1, namely:

Table 1. Interpretation of Reliability

Percentage	Criteria
$0\% \leq r_{11} \leq 20\%$	Very Low
$20\% \leq r_{11} \leq 40\%$	Low
$40\% \leq r_{11} \leq 60\%$	Moderate
$60\% \leq r_{11} \leq 80\%$	High
$80\% \leq r_{11} \leq 100\%$	Very High

The data analysis technique used in this study is qualitative data analysis including: (1) data reduction is the process of selecting the main points, simplifying, and focusing on the important points. In this case, the researcher recorded the interview results and collected test data and documentation from informants related to students' abilities in solving questions, (2) data presentation in the form of information in the form of narrative text that is arranged, summarized, and arranged so that it is easy to understand and plan further research work. The researcher arranges relevant data so that it becomes information that can be concluded and has a certain meaning, (3) drawing conclusions is the stage of data analysis that has been presented in the form of a table. To find out the percentage of errors made by students in solving story questions on the main topic of sequences and series, the following formula is used:

$$P = \frac{\sum s}{\sum s + \sum b} \times 100\%$$

Description:

P = percentage of errors sought

$\sum s$ = number of questions answered incorrectly from the total of all questions

$\sum b$ = the number of questions answered correctly from the total of all questions

To determine the percentage of error rates for all students, the following criteria are determined in the Table 2:

Table 2. Interpretation of Error Rate

Percentage	Criteria
$0\% \leq r_{11} \leq 20\%$	Very Low
$20\% \leq r_{11} \leq 40\%$	Low
$40\% \leq r_{11} \leq 60\%$	Moderate
$60\% \leq r_{11} \leq 80\%$	High
$80\% \leq r_{11} \leq 100\%$	Very High

Result

Before conducting the research, the researcher prepared a research instrument in the form of test questions. The questions prepared were descriptive questions consisting of 5 questions on sequence and series material. After the questions were completed, the researcher tested the questions on class XI TKJ students of SMK Tarbiyatul Aulad Cikajang with a total of 6 students to test their validity and reliability. After the questions were tested, the try out results were calculated using the product moment formula and a significance level of 5% to obtain the r_{xy} product moment price per item. The results are as follows in the Table 3.

Table 3. r_{xy} product moment value per item

Item Number	r_{xy} Value	r_{tabel} Value	Description
1	0,4204	0,811	Invalid
2	0,9522	0,811	Valid
3	0,8933	0,811	Valid
4	0,8730	0,811	Valid
5	0,8607	0,811	Valid
6	0,8412	0,811	Valid
7	0,7959	0,811	Invalid

Then the r_{xy} product moment price is consulted with the r_{tabel} price of the product moment for N = 6 with a significance level of 5% which is 0.811.

From the 7 descriptive questions that were tested, it was found that the $r_{xy} > r_{\text{tabel}}$ value for questions number 2 to 6 so that the questions were valid and the $r_{xy} < r_{\text{tabel}}$ value for questions number 1 and 7 so that the questions were invalid.

Valid data can then be calculated for reliability using the Alpha formula. The results obtained are the value of r_{11} = 0,89 and after being interpreted with the correlation index it is concluded that the question has a very high level of reliability.

After the try out test was carried out to test the validity and reliability of the instrument, the next step was to conduct research to obtain the required data regarding students' abilities in solving story problems on the topic of sequences and series. This research was conducted on 10 students of class XI TKJ SMK Tarbiyatul Aulad Cikajang on February.

From the results of the students' work, data was obtained on the types of errors made by students in working on story problems on the topic of sequences and series reviewed from the language aspect, prerequisite aspect, and applied aspect. The data obtained is presented in the form of a table to make it easier to find out the errors made by students. The data is as follows (see Table 4):

Table 4. Number of Errors Made

Error Type	Number of Items	Question Item Number					Total
		1	2	3	4	5	
Language Aspects	$\sum B$	0	0	10	6	1	17
	$\sum S$	10	10	0	4	9	33
Prerequisite Aspects	$\sum B$	4	0	10	7	1	22
	$\sum S$	6	10	0	3	9	28
Applied Aspects	$\sum B$	0	0	10	8	3	21
	$\sum S$	10	10	0	2	7	29

From the calculation results, Table 4, the average percentage of each aspect of errors made by students was obtained, namely: (1) Errors in the language aspect, namely 66%, are classified as high criteria, (2) Errors in the prerequisite aspect, namely 56%, are classified as medium criteria, (3) Errors in the applied aspect, namely 58%, are classified as medium criteria.

Discussion

To analyze students' errors in solving mathematical problems in the form of stories on the topic of sequences and series, researchers use language aspects, prerequisite aspects, and applied aspects. The following is an analysis of students' errors in each question item.

1) Errors in language aspects

Errors in this aspect are errors made by students in understanding or observing the main topic of sequence and series story questions. So that students have difficulty determining what is known in the question. The errors made by students in this aspect are relatively high, namely 66%. Student errors in this aspect are often made in questions 1, 2, and 5.

Errors in understanding the language occur because students do not understand the language of sequence and series story questions. Most students do not read the questions carefully so they have difficulty translating the language of the question into a mathematical model and determining what is known in the question. Students also do not practice working on story problems related to sequence and series material.

Based on the results of the analysis of student answers, it shows that the level of errors in understanding the language of sequence and series story questions of students at Tarbiyatul Aulad Cikajang Vocational School related to identifying what is known and asked in sequence and series story questions is relatively high.

Based on the analysis of student answers, number 1 shows that the student is still confused in understanding the language of the question to be translated into a

mathematical model. Some students write what is known in the question in words not with the correct mathematical model. This shows that students' ability to understand the language of questions is still very lacking.

2) Errors in prerequisite aspects

Errors in this aspect are errors made by students in determining what is meant or asked in the story questions on the topic of sequences and series, including in determining the formula used to solve the questions. Errors made by students in this aspect are classified as moderate, namely 56%. Student errors in this aspect are often made in questions 2 and 5.

Errors in the prerequisite aspect occur because students do not master the sequence and series material so that in determining what is asked in the question, students make mistakes. Because they do not understand the sequence and series material, the provision for working on the questions is still very lacking. In addition to the lack of student understanding of the material, students also do not practice working on story questions related to sequence and series material, causing students to have difficulty in working on the questions.

Based on the results of the analysis of student answers, it shows that the level of errors in the prerequisite aspect of the sequence and series story questions of students at Tarbiyatul Aulad Cikajang Vocational School related to identifying what is asked in the sequence and series story questions is classified as moderate.

Based on the analysis of student answers number 2, it shows that the student is still confused in understanding the question to be translated into a mathematical model. This results in students making errors in their calculations. This shows that students' ability to understand sequence and series material is still very lacking.

3) Errors in applied aspects

Errors in this aspect are errors made by students in applying formulas or calculating story questions on the topic of sequences and series. Errors made by students in this aspect are classified as moderate, namely 58%. Student errors in this aspect are mostly made in questions 1, 2, and 5.

Calculation errors occur because some students do not answer the question. There are also students who forget the formula so that in their calculations the students use manual calculations.

Based on the results of the analysis of student answers, it shows that the level of error in calculating answers to story questions on sequences and series of students at Tarbiyatul Aulad Cikajang Vocational School related to story questions on sequences and series is classified as moderate.

Based on the analysis of student answers number 5, it shows that the student cannot determine the formula used to solve the problem, so in solving it the student

uses manual calculations. This shows that the students' ability to determine the formula used and calculate the problem is still very lacking.

From the results of the students' work, errors were obtained in making mathematical models. Students were unable to translate the language of the questions into mathematical models and provide symbols for the quantities contained in the questions. Students' errors in making mathematical models were mostly made in number 1.

To measure students' ability to solve story-based math problems on the topic of sequences and series, researchers based it on the scores obtained by students. The scores obtained by students were compared with the Minimum Completion Criteria (KKM), which was 70. If the score obtained ≥ KKM, then the student was considered able to solve story-based math problems on the topic of sequences and series.

From the assessment results, 1 student was able to solve story-based math problems on the topic of sequences and series. While 9 students were unable to solve the problems.

Conclusion

Based on the results of the research analysis and discussion obtained, it can be concluded that students' ability to solve mathematical problems in the form of stories on the topic of sequences and series for class XI TKJ students at SMK Tarbiyatul Aulad Cikajang is as follows: 1) Students' ability to create mathematical models and the ability to solve problems, namely students are unable to translate the language of the problem into a mathematical model and provide symbols for the quantities contained in the problem. Students who are able to solve mathematical problems in the form of stories on the topic of sequences and series are 1 person. Meanwhile, students who are unable to solve mathematical problems in the form of stories on the topic of sequences and series number 9 people because the scores obtained are <70. 2) Mistakes experienced by students in terms of language aspects, prerequisite aspects, and applied aspects are: a) Mistakes in the language aspect are caused by students not understanding the language of the problem and translating the language of the problem into a mathematical model so that students have difficulty in determining what is known in the story problems of sequences and series. b) Errors in prerequisite aspects are caused by students not understanding the material so that students have difficulty in determining what is meant or asked in the story questions on the main topic of sequences and series, including in determining the formula used to solve the problem. Errors in applied aspects are caused by students being less careful in calculating or applying the formula. c) Errors in understanding the problem and determining the known value in the problem greatly affect the calculation results in solving the story questions on the main topic of sequences and series. If the determination of the known value is wrong, then the calculation will also be wrong. 3) The percentage of errors

made by students in terms of language, prerequisite aspects, and applied aspects, namely: a) Errors in the language aspect of 66% are classified as high. These errors include errors in understanding the language to write what is known in the story questions on sequences and series into a mathematical model. b) Errors in the prerequisite aspect of 56% are classified as moderate. These errors include errors in writing what is asked in the story questions on sequences and series, including in determining the formula used to solve the problem. c) Errors in the applied aspect of 58% are classified as moderate. These errors include errors in determining the formula used or calculating sequence and series story problems.

From the data obtained, it can be seen that the most common errors made by students are errors in the language aspect of 66% and are classified as high. This is because students are less able to understand the language and do not practice questions in the form of stories so that they have difficulty writing what is known in the problem into a mathematical model.

Conflict of Interest

The authors declare that no conflict of interest regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancies have been completely by the authors.

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