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ANALYSIS OF STUDENT ERRORS IN SOLVING STORY PROBLEMS ON ARITHMETIC SEQUENCES AND SERIES BASED ON NEWMAN

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ABSTRACT

The purpose of this study was to analyze the types of errors and causal factors that students do in solving story problems on the material of arithmetic sequences and series based on Newman. The type of research used is descriptive research with a qualitative approach. This study was conducted at Senior High School 1 Cigugur. The research subject consisted of 6 students, with 2 high ability students, 2 medium ability students, and 2 low ability students. The subject were taken using purposive sampling technique. Data collection techniques using test sheets, interviews, and documentation. Test the validity of the data using triangulation technique. The result of this study showed the percentage of errors in general was 57 %, with 0 % reading errors, 68,3 % comprehension errors, 53,3 % transformation errors, 73,3 % process skill errors and 90 % encoding errors. The causes of comprehension errors in students with medium ability is that they do not understand arithmetic sequences correctly, and they rush to do test questions because of limited time, while in students with low ability because from the beginning they do not understand the meaning of the questions given. The cause of transformation errors in students with low ability is that they do not know the formula/method used. The cause of process skill errors in high ability students is that they do not understand prioritizing bracketed operations and they rush to do the test questions so that they are not checked again, while in medium and low ability students in the previous stage (comprehension and transformation) they make mistakes. The cause of encoding errors in low ability students is lazy to write conclusions.

Keywords: arithmetic sequences and series, error analysis, mathematics education, newman, research and develovment mathematics education, story problems.

1. Introduction

Education is a very important factor in developing the potential quality of human resources. One way to develop the potential of human resources in the field of education is through learning mathematics. Mathematics is one of the fields of science that underlies many other sciences. Where mathematics has a variety of characteristics or characteristics, one of which is to have an abstract object. In line with the opinion expressed by Nisa (2018) that mathematics is a science with an abstract object of study. Objects or symbols in mathematics do not exist in real life. These characteristics cause many students to have difficulty learning math problems, it allows students to experience errors in answering the questions..

Students mistakes in solving problems have a lot to do with learning disabilities or imperfect learning abilities. In mathematics learning, mistakes in learning a concept in the previous material will affect the understanding of the concept in the next material because mathematics is a systematic lesson. So in the process of learning mathematics, not all students always succeed in achieving learning goals. There are always students who cannot learn. This reflects if the student has difficulties that result in errors in solving the given mathematical problems. Mathematical problems are often associated with phenomena that exist in everyday life. One of the mathematical materials that can be associated with everyday life is arithmetic sequences and series. In its application arithmetic sequences and series are closely related to everyday economic problems, such as growth, decay, interest, and annuities. Therefore, mastering the material on arithmetic sequences and series is very important for students. However, students often have difficulty learning the material. This shows that the literacy and numeracy skills of students are still lacking. The following is a graph of the value of literacy and numeracy skills conducted by (Winata et al., 2021).

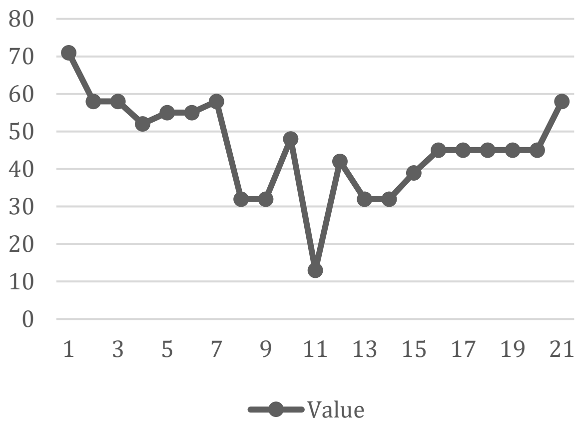

Figure 1 Graph Of Literacy and Numerasi Skill

Based on the data above, it can be stated that of the 21 students who took the literacy and numeracy ability test, about 61.90% of students still had scores below 50. This shows that more than half of the students have literacy and numeracy skills that are included in the low criteria. The ability of students with low criteria reflects If students are still weak in using numbers, symbols or mathematical forms of presentation in solving problems, predicting and making decisions so that it causes students to tend to make mistakes in working on given problems. Therefore, there needs to be a study on the analysis of mistakes made by students.

In addition, from the observation on the activities of PKM III in SMAN 1 Cigugur, researchers found problems obtained from the evaluation of student learning. Most of the students make mistakes in completing the form of story questions. The error occurs because students do not understand the meaning of the questions given. So that students make mistakes in changing the story into a mathematical form. Another mistake made by students is when determining the mathematical model that will be used to solve the problem at the time of calculation. Students tend to use formulas or quick ways that have been used rather than using structured steps to solve math problems. For example, given about :

“Dalam sebuah gedung pertunjukkan disusun kursi dengan baris paling depan terdiri 5 buah, baris kedua berisi 7 buah, baris ketiga 9 buah, baris keempat 11 buah, dan seterusnya. Hitunglah banyaknya kursi pada baris ke-35! ”

The result of the student's answer can be shown as follows.

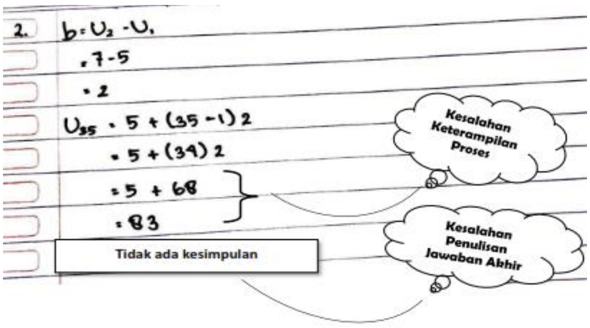

Figure 2 Examples of Work Students and Identifying their Mistakes

Based on Figure 2, at the initial stage it is seen that students can write down what is known from the problem, where in the problem can be found the difference (b) which is the difference from the first term and the second term. However, students cannot write what is asked of the given problem where students should write first what is asked of the problem before proceeding to the next stage of work to prove if he indeed understands the problem given to the problem. So because the student writes down what is known from the question but does not write what is asked means that he makes comprehension errors.

In the next stage, students do not write the formula/method used but students can look for U_{35}, allegedly students forget to write the formula/method used then students make transformation errors. Where at that stage before the calculation process should students write down in advance the formula/way to be used, students can find $U_n = a + (n-1)b$. Then, at the stage of process skills students also make mistakes. Where students can find U_{35}, but at the stage of the final results students are able to work on the problem but less precise in writing the calculation results obtained. The result of the calculation written by the student is 83 where as the correct answer is 73, so the result of the calculation written is not right. Then, at the final stage, students do not write conclusions from the calculation results obtained. This indicates if the student made a mistake in writing the final answer (encoding errors). So from these problems, there is a need for further research related to student errors in working on story problems and arithmetic progression.

As for some previous research related to the analysis of student errors in working on the problem of rows and series, among the research conducted by Septiahani et al. (2020) whose research results show that in working on row and series problems in high school/vocational school/equivalent students, it is still relatively low. In addition, research conducted by Nur et al. (2018) who has conducted research on the analysis of student errors in arithmetic sequence and series material story problems where the results of his research showed the cause of the mistakes made by students in solving arithmetic sequence and series material problems, namely the lack of student understanding of symbols and formulas in arithmetic sequences and series.

Seeing these conditions, researchers are interested in researching the existence of errors in solving story problems related to arithmetic sequences and series. Here the researcher wants to use Newman's error theory or also called Newman's Error Analysis (NEA) to analyze the mistakes made by students. According to Newman (1977) Newman (1977) there are 5 stages to analyzing student errors, including reading errors, comprehension errors, transformation errors, process skill errors, and encoding errors.

There are several previous studies on Newman's error theory, namely research conducted by Erni (2020) which states that the highest percentage of errors lies in the comprehension error indicator of 72% where students do not understand the work steps that must be done even though they already understand the purpose of the questions given. Type of error with the second largest percentage is the process skill error of 68% where students can not perform the procedure correctly and wrong completion of the calculation. The next type of error is the transformation error gets a percentage of 56% where students who make mistakes when converting the problem into a mathematical model. Furthermore, the type of error that occurs is encoding error with a percentage of 52% where students have difficulty writing the final answer. The last type of error with the lowest percentage of reading error is 36% where students cannot read important words in the problem statement and do not understand the meaning of symbols, terms or words in the problem. In addition, research Patac & Patac J.R (2015) also shows most students still have difficulty in solving math problems in understanding and converting problems from math words to math symbols. So also research Trapsilasiwi et al. (2021) which shows that in solving problems related to arithmetic sequences and series based on Newman's theory, reading errors were obtained by 0%, comprehension errors 33.33%, transformation errors 0%, process skill errors 33.33%, and encoding errors 100%. Then Karnasih (2015) showed that the application of NEA in schools abroad has shown positive results in improving students ' ability to solve word problems. The results of several studies in implementing NEA in Australia show success in improving the competence of both teachers and student learning outcomes.

Based on the above discussion, the purpose of this study is to analyze the types of errors and causal factors that students do in solving the problem of the story on the material of arithmetic sequences and series based on Newman.

2. Research Methods

The type of research used is descriptive research with a qualitative approach. The study was conducted at SMA Negeri 1 Cigugur located at Jalan Sukamulya No.12, Cigugur District, Kuningan Regency, West Java Province. Data analysis techniques in this study using Miles and Huberman model which consists of 3 stages, that is data reduction, data presentation and data verification. The instrument used is a test sheet of 3 questions (essay) in the form of story questions with arithmetic progression and sequence material, interview guidelines, and documentation. Test the validity of the data in this study using triangulation techniques, where researchers will check the data from the same source with different techniques.

Taking the subjects in this study using purposive sampling technique, which means that the subjects to be studied were selected based on the consideration of the researcher according to the purpose and then the subjects were taken randomly (Sugiono, 2013). The subjects taken were as many as 6 people, consisting of 2 high-ability students, 2 medium-ability students, and 2 low-ability students. Before the researchers took 6 subjects for research, the researchers gave the material test questions rows and arithmetic progression to all students of class XI mathematics and natural sciences 2 consisting of 20 students, after being given the test the researchers corrected the students ' answers and gave the appropriate score based on a predetermined Newman indicator, then the researchers calculated the percentage of errors made by students, after that the researchers chose 6 subjects with predetermined criteria to represent each error based on the Newman error indicator. Data collection was carried out in March - May 2022.

3. Result and Discussion

Based on the test results that have been done then to facilitate researchers in the process of data analysis can be made coding the subject of research. The following are the students selected as research subjects.

Table 1 Coding Of Research Subjects

No.	Initials	Category	Subject Code
1.	MNK	High	**H-1**
2.	IAP	High	**H-2**
3.	DKI	Medium	**M-1**
4.	AAN	Medium	**M-2**
5.	RN	Low	**L-1**
6.	SFN	Low	**L-2**

In addition, the details of the results of data analysis on the types of errors made by students in the arithmetic progression and sequence materials based on the results of tests and interviews that have been conducted can be presented in Table 2.

Table 2 Details The Types Of Mistakes Students Make

Research Subject	Problem Number	Newman Error Indicator				
		I1	I2	I3	I4	I5
H-1	1a	-	-	-	-	-
	1b	-	-	-	-	√
	2	-	-	-	-	-
H-2	1a	-	-	-	-	-
	1b	-	-	-	-	√
	2	-	-	-	-	-
M-1	1a	-	-	-	-	-
	1b	-	√	√	√	-
	2	-	-	√	√	-
M-2	1a	-	-	-	-	-
	1b	-	√	√	√	-
	2	-	-	√	√	-
L-1	1a	-	-	√	√	√
	1b	-	√	√	√	√
	2	-	√	√	√	√
L-2	1a	-	-	√	√	√
	1b	-	√	√	√	√
	2	-	√	√	√	√

Description :

I1 : Reading Errors
I2 : Comprehension Errors
I3 : Transformation Errors
I4 : Process Skill Errors
I5 : Encoding Errors

Based on Table 2, a diagram can be made that states the percentage of mistakes made by students, which is as follows.

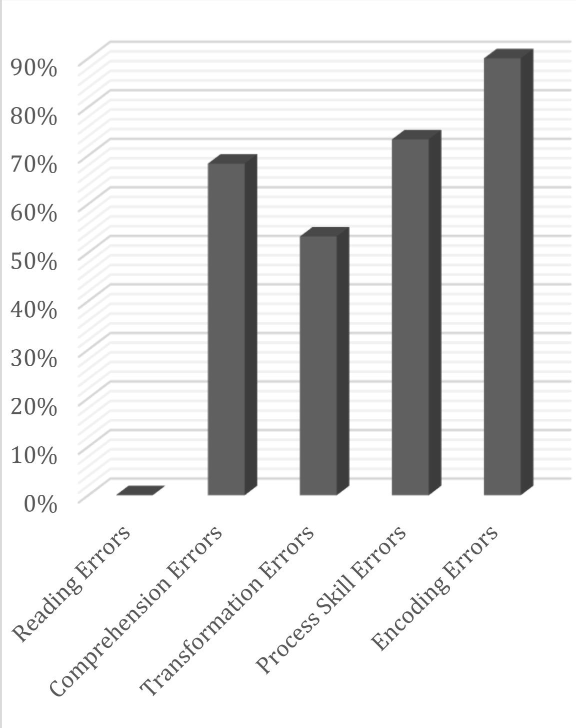

Figure 3 Percentage Of Student Error

In the diagram above, it can be seen if the percentage rate of reading errors committed by students is 0 %. This type of error is a mistake with the smallest percentage level, where both high, medium, and low ability students do not make mistakes because all students are able to read the questions and interpret the meaning of the words asked in all existing questions (problem 1a s/d problem 2) well and correctly without any errors in pronunciation. In line with Satoto et al. (2013) in the results of his research which concluded that of the 6 research subjects all were able to pass the reading stage without any errors. Then, Jha (2012) who said that students are said to have gone through the reading stage if students can read the questions clearly and can find the keywords contained in the questions. This can prove if the student's literacy skills are very good at reading the questions given.

Furthermore, the percentage rate of comprehension errors is 68,3 %. This type of error is the error with the third highest percentage rate. Where high ability students do not make mistakes at this stage, the average of medium and low ability students make mistakes in questions number 1b and 2. The average student cannot write down the information that is known and asked about and there are also those who only write one of them. Factors that cause students to make mistakes is because students do not understand the sequence and arithmetic progression correctly, but also students rush to work on the problem because of limited time, and since the beginning of the students do not understand the meaning of the questions given. Error understanding the problem is the fault of the students after the students are able to read the problem given, but can not capture the information contained in the problem so that students can not solve the problem given (Singh et al., 2010). This is in line with the research of Annisa dan Kartini (2021) which states that students make mistakes because students cannot identify what is known precisely, causing misinterpretation and do not read the questions carefully so that there is information about the missed questions, do not understand the overall meaning of the questions well so that they are inconsistent in identifying known things, are unable to explain the information contained in the questions appropriately. In addition, Sari et al. (2019) concluded if the student made a misunderstanding because the student was unable to write a known and asked question even though the student understood the question presented.

In addition, the rate of errors made by students on the type of transformation errors is equal to 53,3 %. This type of error is the error with the fourth highest percentage rate. Where high-ability students here do not make mistakes transformation, because it can write down the way/formula used appropriately as requested problem. While students with medium ability on average make mistakes in the transformation of problem numbers 1b and 2, and students with low ability on average make mistakes in the transformation of all problem numbers (1 s/d 2). As for the factors causing the student to make mistakes, that is because in the previous stage (stage of understanding) students make mistakes so that they cannot determine the steps/formulas that will be used appropriately. In line Septiahani et al. (2020) which states that in working on row and series problems, students tend to have the same type of error, namely students cannot work on problems because they do not know the procedures or steps that will be used to solve the problems appropriately and are unable to create mathematical models from the information obtained so that they make transformation errors. This is in line with the results of Patac & Patac J.R, (2015) who said that the transformation error is a mistake that is often done by students where students can not choose the right steps or approaches to solve a given problem.

The level of errors made by students in the type of process skill errors is equal to 73,3 %. This type of error is the error with the second highest percentage rate. Where high-ability students have not made mistakes at this stage, the average capable students are making process skill errors in questions number 1b and 2, and low-ability students on average make process skill errors in all problem numbers (1 s/d 2). Factors that cause students to make mistakes, including students wrong in doing calculations because they do not understand prioritizing the bracketed operations and students are also in a hurry to do so that they are not checked again, and because at the previous stage (stage of understanding and transformation) students make mistakes. This is in line with research conducted by Trapsilasiwi et al. (2021) which says that process skill errors occur due to the influence of the previous students make mistakes in the previous stage (understanding and transformation stage). In addition, Erni (2020) research which states that the type of process skill error can occur because students cannot perform the completion procedure correctly and students are wrong in doing calculations.

Encoding errors represent the highest percentage of errors among others, which is 90 %. Where high and medium ability students have not made mistakes at this stage, but low ability students on average make mistakes in writing the final answer on all question numbers (1 s/d 2). The factors that cause students to make mistakes are because students are lazy to write conclusions and students are in the previous stage (stage of understanding, transformation, and process skills) make mistakes. This is in line with.Jha (2012) said that the error in concluding the final answer is the type of error made if the student is able to do the calculation process well, but can not write the final result in the form of sentences. In line with Gumati dan Kartini (2022) who stated that students made a mistake writing the end of the answer where students only worked to the limit of obtaining numbers, without writing the conclusion as the end of the answer

Based on the results of the calculation of the percentage of each type of error can be obtained in general total errors made by students of class XI mathematics and natural sciences 2 SMAN 1 Cigugur in working on the problem of story lines and arithmetic progression of 57 %. Where the biggest mistake made by students is encoding errors with a percentage of 90 %, while the smallest error lies in reading errors with a percentage of 0 %.

4. Conclusions

Based on the results and discussion, it can be concluded that students mistakes in solving story problems based on Newman's error analysis showed the percentage of errors in general was 57 %, with 0 % reading errors, 68,3 % comprehension errors, 53,3 % transformation errors, 73,3 % process skill errors and 90 % encoding errors. The causes of comprehension errors in students with medium ability is that they do not understand arithmetic sequences correctly, and they rush to do test questions because of limited time, while in students with low ability because from the beginning they do not understand the meaning of the questions given. The cause of transformation errors in students with low ability is that they do not know the formula/method used. The cause of process skill errors in high ability students is that they do not understand prioritizing bracketed operations and they rush to do the test questions so that they are not checked again, while in medium and low ability students in the previous stage (comprehension and transformation) they make mistakes. The cause of encoding errors in low ability students is lazy to write conclusions.

Therefore, based on the results of this study the researchers put forward some suggestions as follows.

1. We recommend that to minimize errors in the work on the problem, students are given first learning and practice questions intensively, where the learning material is more associated with the surrounding environment and daily life so that students will be easier to find what information is known and asked from the questions given
2. It is better to minimize the transformation errors in the problem work, students are more emphasized not to memorize mathematical formulas but to better understand the basic concepts. Teachers should provide basic concepts of mathematical formulas so that students can get used to working on the problem by using the step of the problem solving process so that they are not fixated on the usual formulas that students memorize.
3. We recommend to minimize errors in the process of processing skills, students are given practice questions that vary in order to improve the ability of students ' skills and accuracy in performing calculations so that students can perform calculations appropriately.
4. We recommend that to minimize mistakes made by students, teachers conduct intensive guidance for students who experience errors in doing math problems and students who have low cognitive ability.

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