

Analysis of the Mathematical Comprehension Ability of Grade XI Students on Story Problems Material on Arithmetic Sequences and Series

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Abstract. The purpose of this study was to obtain a profile of the mathematical understanding ability of class XI students on story problems in Arithmetic Sequences and Series material. Qualitative research methods were used in this study, with descriptive analysis techniques. The research was conducted at SMAN 1 Rogojampi with 38 class XI students as the research subjects. The research instrument is a test to analyze comprehension skills and interview guidelines. Several stages of research are planning, implementation and observation. Then, explore students' mathematical understanding abilities by using 4 test items. After that interviews were conducted with students. The results in this study stated that the level of students' mathematical understanding ability was classified as in the medium category. It could be seen that overall students were still lacking in understanding the concept of the material so they could not use the formula correctly when answering the questions given.

Keywords: Mathematical understanding ability, Story problems, arithmetic sequences and series

Abstrak. Tujuan penelitian ini adalah untuk mendapatkan gambaran baru terkait kemampuan pemahaman matematis siswa kelas XI pada soal Cerita Materi Barisan dan Deret Aritmatika. Metode penelitian kualitatif digunakan pada penelitian ini, dengan teknik analisis deskriptif. Penelitian dilakukan di SMAN 1 Rogojampi dengan subjek penelitiannya sebanyak 38 siswa kelas XI. Instrumen penelitiannya adalah test untuk menganalisis kemampuan pemahaman dan pedoman wawancara. Beberapa tahapan penelitiannya yaitu perencanaan, pelaksanaan dan pengamatan. Kemudian, mengeksplorasi kemampuan pemahaman matematis siswa dengan menggunakan 4 butir soal tes. Setelah itu dilakukan wawancara kepada siswa. Hasil dalam penelitian ini menyatakan bahwa, tingkat kemampuan pemahaman matematis siswa tergolong dalam kategori sedang, hal ini terlihat bahwa secara keseluruhan siswa masih kurang dalam memahami konsep materi sehingga tidak dapat menggunakan rumus dengan benar ketika menjawab soal yang diberikan.

Kata kunci: Kemampuan pemahaman matematis, soal cerita, barisan dan deret aritmatika

INTRODUCTION

The ability of students' understanding of mathematics is still relatively low and this has always been a problem in Indonesia, namely in the field of education. This statement is supported by the findings of the 2015 PISA (Program for International Student Assessment) study, which found that Indonesian students occupy the bottom 8th position out of a total of 70 countries, especially in terms of math ability (OECD, 2016). Then, one of the assessments carried out by Trends International Mathematics and Science Study (TIMSS) is related to mathematical understanding. So in this case, the ability to understand mathematics is one of the important skills that students must have. Mathematical understanding has a relation with the understanding of a concept. So that when students can understand concepts well, these students will have good mathematical understanding skills (Duffin & Simpson, 2000)

Several factors are suspected to be related to the low ability of understanding mathematics, namely the lack of interest and attention from students towards mathematics. Furthermore, the mathematics subject at school seems to be oriented towards mainly focusing on text books and is not connected with the real-life situations of students in class (Maria, 2012). Students are not supposed to only remember a theory and a mathematical formula, but they also have to carry out more independent activities to discover the concepts being studied. Nabillah & Abadi (2019) state that the factors causing low student learning outcomes include a lack of interest and motivation to learn from students itself, understanding of material concepts is still low, and the methods used by the teacher. So in this case, the factor of low understanding of mathematical concepts will affect the quality of students' mathematics learning outcomes.

Another factor that becomes one of the influences on understanding is the way of learning. Few of the students studied the material before being taught by the teacher because students relied more on the teacher to explain it first. According to Putra & Purwasih (2016) reading and studying material before learning in class can foster a deeper understanding of the material that will be explained by the teacher. Furthermore in Putra et al., (2018) explained that in order for students to have better

understanding and deepen the material, it is necessary to encourage them to look for concepts from other sources or online media to increase their understanding of these concepts. Thus, they do not just rely on the teacher's explanation and books from the school.

Furthermore, the teacher can relate mathematical material to students' daily lives through story question, because story questions can train students' mathematical understanding abilities. This statement is supported in the results of Khoshaim (2020) that giving story questions to students can be used to assess the level of student understanding of mathematics. In addition, students' mathematical abilities can increase when contextual-based learning is carried out (Bernard, 2015). So in this case, giving st in learningory question mathematics can be used as an alternative by teacher to improve students' mathematical understanding abilities.

Based on research that is relevant to mathematical understanding abilities, namely research by Putra et al., (2018) stated that the mathematical abilities of students at the schools they studied were still in the low category, through this research to test students' mathematical understanding by giving tests on rectangular material. Furthermore, research conducted by Mulyani et al., (2018) stated that students' mathematical understanding through tests of algebra was also still in the low category. Furthermore, Rahayu & Heni (2022) explained that the results of his research related to students' mathematical abilities were classified as low in set material.

From some of these relevant studies, the researcher wanted to get a new picture regarding the profile of students' mathematical understanding abilities which were analyzed through test results from students' answers to contextual story questions, why did the researcher choose story questions because based on the description above that the urgency of giving story questions to students had an effect to improve students' mathematical understanding ability. Thus, it is necessary to conduct research related to students' mathematical understanding of story question, specifically in the material of arithmetic sequences and series.

The questions for the arithmetic sequences and series themselves were chosen in accordance with the PISA-based assessment targets, namely one of them is a

sequence and series. This material is one of several materials taken by class XI SMA. For this reason, it is hoped that later this research can be used as a reference for educators (teachers) to provide the concept of series and arithmetic series that are easier for students to understand, so that students can have good mathematical understanding skills.

METHOD

Qualitative research methods were used in this study, with descriptive analysis techniques. Descriptive analysis is a technique used to analyze a data that has been obtained and then described in order to obtain a conclusion. The research was conducted at SMAN 1 Rogojampi Banyuwangi Regency with 38 class XI students as the research subjects. Through purposive technique, 4 subjects with correct answers and 4 subjects with wrong answers were selected.

The research instrument used was a test to analyze comprehension skills and interview guidelines. Several stages of the research were carried out including planning, namely compiling the instrument, then implementation, namely giving the instrument test to students with story questions on the material series and the last thing to do was observation, namely analyzing student answers after completing the test questions.

According to Alfina & Sutirna (2022) the questions tested on students must meet the specified ability criteria (indicators). Such as applying formulas to calculations, changing one form into another, applying material concepts, and linking one concept to another. The maximum answer score for each question is 5 so that all correct scores for all questions are 20.

To find out the indicators of students' mathematical understanding abilities, the following formula is used:

$$\text{Nilai} = \frac{\text{Scores obtained by students}}{\text{The maximum score all correct}} \times 100\%$$

Suherman & Sukjaya (1990) in their books explained the criteria for students' mathematical comprehension abilities which were divided into several categories. Can be seen in table 1.

Value	Category
90% until 100%	Very High
75% until 89%	High
55% until 74%	Medium
40% until 54%	Low
0% until 39%	Very Low

Table 1. Mathematical Understanding Ability Category

Table 1 shows the criteria for mathematical understanding abilities which are divided into 5 categories. The five categories are used to obtain a classification based on the level of students' understanding of mathematics seen through the results of their answers.

RESULTS AND DISCUSSION

The following results were obtained from the research through the results of the answers of students who had completed story questions on arithmetic sequences and series material, each of which was also in accordance with the indicators in students' mathematical understanding. The following is a summary of the results of the scores from students and a description of each student's mistakes.

Score	Value	Category	Total Student (TS)	Percentage (TS)	Error Description
20	100%	Very High	2	5.26%	Students have been able to complete all the questions in detail and correctly.
19	95%		1	2.63%	Students answered all the questions but there was still one question where the symbol was wrong.
18	90%		1	2.63%	Students answered all questions but were still incomplete in writing the solution.
17	85%	High	0	0	There were no students who got a score of 17.
16	80%		2	5.26%	Students are able to answer all questions, but one question is done directly without applying the formula.
15	75%		4	10.53%	Students were only able to answer three questions correctly
14	70%	Medium	5	13.16%	Students answered three questions correctly but one question answered incomplete (without a formula).
13	65%		7	18.42%	Students only answered three questions but one of the questions wrote the wrong final settlement count
12	60%		5	13.16%	Students only answer two questions correctly, write down what is known in the problem.
11	55%	Low	0	0	There are no students who get a score of 11
10	50%		4	10.53%	Students only answered two questions correctly.
9	45%		0	0	There were no students who got a score of 9.
8	40%	Very Low	5	13.16%	There were no students who got a score of 9
7	35%		0	0	There were no students who got a score of 9
6	30%		1	2.63%	Students are only able to change three questions into patterns.
5	25%	Very Low	0	0	There are no students who get a score of 5.
4	20%		1	2.63%	Students just rewrite all questions
3	15%		0	0	There are no students who get a score 3.
2	10%		0	0	There are no students who get score 2.
1	5%		0	0	There are no students who get a score of 1.

Table 2. Summary of Student Score Results and Error Descriptions

Table 2 presents a summary of the results of student scores with a detailed score of 1-20, which is a description of the four item scores with the maximum score for each question being 5. So the highest score if the student answers all the questions in detail and correctly gets a score of 20. To be more concise regarding the results of student scores and their categories can be seen in table 3.

Category	Total Student (TS)	Percentage (TS)
Very High	4	10.53%
High	6	15.79%
Medium	17	44.74%
Low	9	23.68%
Very Low	2	5.26%
Total	38	100%

Table 3. Category of Students' Mathematical Understanding Ability

Based on table 3 it can be obtained an explanation that out of 38 students there were 4 students (10.53%) students who had comprehension abilities in the very high category, while in the high category there were 6 students (15.79%), in the medium category there were 17 students (44.74%), in the low category there are 9 students (23.68%), and in the very low category there are 2 students (5.26%).

Then from table 3 it can be classified into 3 categories, including High (H), medium (M), and Low (L). Where the high category is a combination of very high and high categories, while the low category is a combination of low and very low categories. As for more details, it can be seen in table 4 below.

Category	Total Student	Percentage
High	10	26.32%
Medium	17	44.74%
Low	11	28.95%
Total	38	100%

Table 4. Classification of Students' Mathematical Comprehension Ability

The percentage of students' mathematical understanding ability in table 4 is classified from 38 students, there are 10 students (26.32%) who have comprehension abilities in the high category, while in the medium category there are 17 students (44.74%), and in the low category there are 11 students (28.95%). So from this classification, and looking at the percentage, students are already

classified as in the medium category in terms of students' mathematical understanding abilities. Even though in the medium category there are still many students who do not understand the concept of using formulas properly, because they are only at the level of memorizing, not understanding.

In order to understand where the students' mistakes were when solving mathematical comprehension ability questions, the following is a discussion of the researcher's description regarding student errors when working on mathematical comprehension ability questions on story question of arithmetic sequences and series.

1. Analysis of students' answers on questions about the ability to understand mathematical sequences and contextual arithmetic series in question 1.

Mr. Azrul is the owner of a car factory. The factory assembles 10 units of cars in the first month. In fact, there were so many car enthusiasts that they produced another 15 units in the second month. Then increase again in the third month by 20 units, and so on. When will Pak Azrul's factory produce 100 cars a month?

Figure 1. Question

The results of student answers are wrong in question 1

Shown in Figure 2. One representative student answer is wrong in question 1

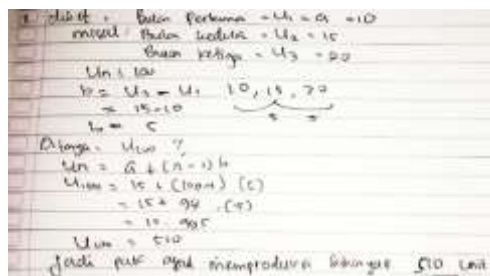


Figure 2. Representative Student Answers Wrong in Question 1

Figure 2 The students already understand what is known in the problem, namely the first month is U_1 , the second month is U_2 and the third month is U_3 , students are also able to calculate the difference from these questions using the formula $U_2 - U_1$ so that the difference is 5. But in when entering what is being

asked in the question, students begin to make mistakes. Students assume that $U_n = U_{100}$ is what is being asked (production of car units) so students get answers of 510 car units calculated by the U_n formula.

From this description, the mistakes made by students were not understanding the use of the concept of the U_n formula, what should be asked is n . This is when researchers conduct interviews with students, it turns out that students are still having difficulties with using sequence and series formulas, many are still confused, but many also say they are not happy in mathematics because it is considered that everything is just about remembering formulas but when applied to problems they are still confused .

Students who answered correctly in question number 1

Shown in Figure 3 is one of the representatives from the student's answer who answered correctly in question number 1

1) Diket : Bulan pertama = $U_1 = a = 10$
 Bulan kedua = $U_2 = 15$
 Bulan ketiga = $U_3 = 20$
 $U_n = 100$
 $b = U_2 - U_1 = 15 - 10 = 5$

~~Ditanya~~
 Ditanya : $n = \dots ?$

$U_n = a + (n-1)b$
 $100 = 10 + (n-1)5$
 $100 = 10 + 5n - 5$
 $100 = 5 + 5n$
 $95 = 5n$
 $19 = n$
 Jadi, Pabrik Pak Asrul memproduksi 100 unit mobil pada bulan ke-19.

Figure 3. One Representative Student Answer Correct on Question 1

Figure 3 can be concluded that students are able to understand all the concepts of arithmetic sequences, because it can be seen that the student's answer process starts from the example that is known to that which is solved through the formula $U_n = a + (n-1)b$ where U_n is known, namely 100 so that what is sought is n , then $100 = 10 + (n-1)b$ so that the final solution is 100 units, it is correct and fixed

During the interviews, the students answered that question 1 was relatively easy and had understood the concept of using the arithmetic sequence formula, so there were no difficulties. In addition, these students prefer to solve math problems

in the form of stories (contextual) because according to them they are easier to understand.

2. Analysis of students' answers on questions about the ability to understand mathematical sequences and contextual arithmetic series in question 2.

Ms Vio is the owner of a boutique in Banyuwangi. It turned out that there were 6 clothes sold during the month, however, in the second month the clothes were sold as many as 9 pieces. Then, in the third month, 12 clothes were sold and continued to increase by 3 clothes per month. Find the number of clothes sold in the 15th month!

Figure 4. Question 2

The results of student answers are wrong in question 2

Shown in Figure 5 is one of the student's representative answers that were wrong in question number 2.

2) data : 6, 9, 12, ...
 $a = 6$
 $b = 3$
 Ditanya $n = ?$
 Jawab $U_n = a + (n-1)b$
 $15 = 6 + (n-1) \cdot 3$
 $15 = 6 + 3n - 3$
 $15 = 3 + 3n$
 $12 = 3n$
 $4 = n$

Figure 5. One Incorrect Representative answered Question 2

Figure 5, students already understand the problem well, are also able to change the story question into a number pattern, namely 6, 9, 12 where 6 is U_1 , 9 is U_2 , and 12 is U_3 . However, when entering the question and solving the problem, the student made a mistake in substituting what was known into the arithmetic sequence formula, because what should be asked in the problem was U_n , but the student assumed that what was asked was n (clothes sold), so the student obtained the result $n = 4$

From the description of the analysis above, the mistakes made by students were not understanding the concept of the difference between U_n and n , where U_n is the n th term of an arithmetic sequence, while n is the value of the number of terms in an arithmetic sequence. So that the misunderstanding of this concept results in students misinterpreting when understanding the question. Then the researcher conducted interviews, the students answered that if they looked for U_n and n , they were often wrong, because they did not fully understand the two differences when applied to the questions.

Students who answered correctly in question number 2

Shown in Figure 6 is one of the representative student answers that were correct in question number 2.

$$\textcircled{2} \quad a = 6 \quad \text{Jawab : } U_n = a + (n-1)b$$

$$b = 3 \quad \quad \quad = 6 + (15-1)3$$

$$n = 15 \quad \quad \quad = 6 + (14)3$$

$$U_n = \dots ? \quad \quad \quad = 6 + 42$$

$$\quad \quad \quad \quad \quad \quad = 48$$

Jadi baju yg terjual pada bulan fe-15 adalah 48 buah baju

Figure 6. One Representative Student Answer Correct on Question 2

Figure 6 students have done the problem solving quite well and correctly. The question is solved by using the arithmetic sequence formula, then entering what is known in the question into the formula, namely $a=6$; $b=3$; and $n = 15$. So that the answer is 48 (U_{48}). However, even though it was correct, the answer did not use sentences such as knowing how many clothes were originally sold, the number of clothes sold, and so on.

Then the researcher tried to interview why the details were not written down, it turned out that students said that it would be more complicated if it was written in sentences first and would take longer, but students also said that they would be happier if they worked on questions in the form of a story in figure 4, according to them, they were interested in answering if it is associated with real life it is more improved than just looking at questions in the form of numbers.

3. Analysis of students' answers on the question of ability to understand mathematical sequences and arithmetic series in question 3

An auditorium has 15 rows of seats. 9 seats are in the front row. Second row 14 seats. Then after 19 seats and so on. How many seats are there in the auditorium?

Figure 7. Question 3

The results of student answers are wrong in question 3

Shown in Figure 8. One representative student answer that is wrong in question number 3

③ Dik. $n = 15$
 $a = 9$
 $b = 5$
 Ditanya. S_n ...
 $S_n = n(2a + (n-1)b)$
 $S_{15} = 15(2(9) + (15-1)5)$
 $= 15(18 + 70)$
 $= 15(88)$
 $= 1320$
 $S_{15} = 1320$
 jadi banyak kursi adalah 1320

Figure 8. One Representative Student Answer Wrong on Question 3

Figure 8 above, students already understand, for example, with what is known in the problem, namely the number of seats in the first row is a . Students are also able to calculate the difference in the question, which is 5. Students also understand the use of the arithmetic series formula in the problem. However, the students were wrong in writing the formula for an arithmetic series, ie without multiplying n by $\frac{1}{2}$. That's why the answer obtained is wrong.

From this description, the mistakes made by students were errors in writing formulas which resulted in wrong answers being obtained. This is when the researcher conducted interviews with students, it turned out that the students actually memorized the arithmetic series formula, but were not careful in writing it down.

Students who answered correctly in question number 3

Shown in Figure 9 is one of the representative student answers that were correct in question 9 number 3

$$S_n = \frac{n}{2} (2a + (n-1)b)$$

$$S_{15} = \frac{15}{2} (2 \times 9 + (15-1)5)$$

$$= \frac{15}{2} (18 + 70)$$

$$= \frac{15}{2} \times 88$$

$$= 660 \text{ seats}$$

Figure 9. One Representative Student Answer Correct on Question 3

Can be seen in Figure 9, students already understand the questions well and are also able to change the story question into the form of a number pattern, namely U1, U2, U3 are 9, 14, 19. Then students also understand the use of the concept of the arithmetic series formula so that when solved is $S_{15} = 15/2 (2 \cdot 9 + (15-1)5)$ and the answer is 660 seats (S_{15}).

Then the researcher also tried to conduct interviews, students said that the problem was relatively easy to solve, several other students who answered correctly also said that sory question were easier to solve, especially if they already understood the concept of formulas for arithmetic sequences and series.

4. Analysis of students' answers on questions about the ability to understand mathematical sequences and contextual arithmetic series in question 4.

The fry seller worked for one month in July, when the first day he sold 10 fries, while on the 2nd day a total of 13, and on the 3rd day a total of 16, then repeated a total of 3 every day. Determine how many fries were sold on the 29th day

Figure 10. Question 4

The results of student answers that are wrong in question 4

Shown in Figure 11 is a representative student answer that is wrong in question 4

(4) Diket = $a = 10$ $b = 3$
 $U_2 = 13$ $n = 29$
 $U_3 = 16$
 Dit = $S_n = ?$
 Jwb = $S_n = \frac{1}{2} n(2a + (n-1)b)$
 $= \frac{1}{2} (2 \cdot 10 + (29-1) \cdot 3)$
 $= \frac{1}{2} (20 + (28 \cdot 3))$
 $= \frac{1}{2} (20 + 84)$
 $= \frac{1}{2} (104)$
 $= 29 \cdot 52$
 $= 1.508$
 Jawaban terjual pada hari ke-29 adalah 1.508

Figure 11. One Representative Student Answer Wrong on Question 4

Figure 11 students already understand what is known in the problem, namely the first day is a , the second day is U_2 and the third day is U_3 , students are also able to calculate the difference from the question, which is 5. But when entering what is asked in the problem, students start doing error, students assume that what is being asked is the number of fried foods sold from the first day to the 29th day so they use the arithmetic series formula. Even though in the question being asked is the number of fried foods sold on the 29th day only, meaning the formula used is the arithmetic sequence in the 29th term (U_{29}).

From this description, the mistakes made by students were errors in understanding the meaning of the questions resulting in errors in identifying what was being asked. This is when researchers conduct interviews with students, it turns out that students still have difficulty in distinguishing which story question are solved using arithmetic sequences and which story question are solved using arithmetic sequences.

Students who answered correctly in question number 4

Shown in Figure 12 is one of the representatives from the completion of students who answered correctly in answering question 4.

(4) $10, 13, 16, \dots, U_{29}$
 Diket =
 $U_1 = 10$
 $b = 3$
 $n = 29$
 Jawab =
 $U_{29} = 10 + (29-1)3$
 $= 10 + (28)3$
 $= 10 + 84$
 $= 94$

Figure 12. One Representative Student Answer Correct on Question 4

In Figure 12 it can be concluded that students have understood all the concepts of arithmetic sequences, because it can be seen that the student's answer process starts from writing the correct sequence of numbers based on the information contained in the question. Then write what is known in the problem by symbolizing it according to the concept of an arithmetic sequence. After that, students solve question using the formula for an arithmetic sequence. Even without writing down the formula first, students can find the correct solution to the question, which is 94.

During the interviews, the students answered that question 4 was relatively easy and had understood the concept of using the arithmetic sequence formula, so there were no difficulties. In addition, these students prefer to solve math problems in the form of stories (contextual) because according to them they are easier to understand. However, students say that they prefer to solve question mathematically rather than using sentences that are too long so that at the end of the completion no concluding sentences are given.

Table 3 shows that 4 students are in the very high ability category. This shows that students can understand the problem, and represent information from the problem in a mathematical form so that students can solve the problem well (Maghfiroh & Rohayati, 2020). However, this ability is not possessed by all students in the class. Of the 4 students who were in the very high category, it turned out that there were 2 of them who were not careful in presenting information so the answers were wrong. So the ability to understand mathematics is the whole of the ability to understand the problem, represent it in a mathematical form, and have accuracy in solving problems (Susiatiy & Haryadi, 2019).

The results of the research carried out are in line with the findings of research conducted by Fajar et al., (2019) the results of which illustrate that most students' ability to understand mathematics is still relatively low. This is reinforced by evidence when researchers directly observe in the field that this low understanding ability is due to the low ability to represent information in word problems in mathematical form. Another lack of understanding is also shown that there is a factor of lack of accuracy. Most students are still in a hurry in working on the

questions, so they pay less attention to punctuation or other writing which causes the final result in working on the problem to be wrong.

Another possibility for the low ability to understand mathematics is contained in the research results of Auliya (2016) which also shows the existence of a factor of self-confidence or self-efficacy. Students already understand the information and can represent it in mathematical form but some of the students do not have sufficient self-confidence so that students choose not to solve the problems given.

CONCLUSIONS

Based on the description of the results and discussion above, it is concluded that students' mathematical understanding abilities in answering math questions, especially in contextual story questions on arithmetic sequences and series material for class XI, are classified from 38 students, there are 10 students (26.32%) who have comprehension abilities in the high category, while in the medium category there were 17 students (44.74%), and in the low category there were 11 students (28.95%). Thus, it can be seen from this percentage that students are classified as in the medium category in terms of students' mathematical understanding abilities. Even though it is classified as in the medium category, there are still few students who make mistakes in solving mathematical comprehension ability questions. This is because students say that they don't like memorizing formulas, some students say because don't understand the meaning of the concept of arithmetic sequences and series, and some say they don't like mathematics during interviews.

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