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ANALYSIS OF STUDENTS' MATHEMATICAL LITERACY ABILITY ON SEQUENCES AND SERIES MATERIAL THROUGH THE APPLICATION OF PROBLEM BASED LEARNING

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ABSTRACT

Mathematical literacy ability is the ability to understand and to use mathematics in various contexts to solve problems and explain how mathematics can be applied in everyday life. The aim of this study was to analyze students' mathematical literacy abilities in the material for sequences and series using problem based learning (PBL). The sample of this research was class XI SMA as many as 36 students and the subject was determined using purposive sampling. Tests, interviews, and documentation were used as data collection techniques. The research instrument was in the form of a mathematical literacy ability test on sequences and series material as well as interview guidelines that had been validated therefore the instrument being suitable for use. The results of the study showed that the application of PBL to the matter of sequences and series was able to achieve students' mathematical literacy skills. Students can solve problems systematically and correctly even though there are operations such as multiplication or addition of numbers or variables an error occurs and students from both high and low categories do not write conclusions at the end of the problem. From the ability to choose a strategy students are able to identify the information contained in the question, but not yet fully students can decide on a strategy and apply facts, operations and structures in finding solutions related to story problems on sequences and series material.

Keywords: Mathematical Literacy Skills, Sequences and Series, Problem Based Learning

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PRELIMINARY

Mathematics is a science that must be studied by students from elementary school to university because mathematics is a science that drives science and technology progress (Setyawan, 2022). Mathematics plays an important role and needs to be learned from an early age, by studying mathematics a person can improve his thinking skills (Datreni, 2022). This is in line with the target of learning mathematics, namely students are able to hone their mathematical literacy skills and are willing to work together (Farida et al., 2019). Therefore, mathematics needs to be studied in a fun way, the availability of material

greatly influences the process and results of learning mathematics (Puspitasari et al., 2022). Every teacher in an education unit is required to develop comprehensive and systematic learning instruments so that learning becomes interactive and provides space for students to channel their talents to the fullest (Arif et al., 2021). Development of necessary materials such as approaches, methodologies, and learning models to improve students' abilities (Nurhasanah et al., 2022).

One learning model that can help teachers interpret material is problem based learning (PBL) (Puspitasari et al., 2022). Problem based learning provides opportunities for students to be active, helps students analyze math problems, and teaches discussion skills (Lisadwati et al., 2022). Problem based learning is a learning model that has the principle that questions can serve as a starting point for acquiring or integrating new knowledge (Pebriani, 2022). Problem-based learning leads students to feel restless because of gaps that occur in their environment, as a result they feel lacking in themselves and must try to find solutions to these problems. (Ramadhan, 2021). PBL indicators include orienting students during learning, organizing students during learning, directing individual and group research, developing and presenting results, analyzing and evaluating the process and results of problem solving (Kumullah et al., 2018). By applying Problem Based Learning, students face problems in everyday life. This model is suitable for learning in the development of mathematical literacy abilities (Asih & Asih, n.d.).

In the context of learning literacy skills are an important competency for students to master subjects (Annisa, 2022). Mathematical literacy skills are very important because mathematics is very closely related to everyday life (Muzaki & Masjudin, 2019). Mathematical literacy ability is one of the high-level abilities. This is in line with the main research of PISA, namely reading literacy, scientific literacy and mathematical literacy (Masfufah & Afriansyah, 2021). Mathematical literacy skills include formulating, solving, interpreting, and reasoning mathematically (Lutfiyah, 2022). Mathematics has a relationship with mathematical literacy, namely the ability of individuals to create, apply, and understand mathematics in various conditions depending on their ability to think mathematically and use concepts, methods, and facts to describe, explain, or predict phenomena or events (Ananda & Wandini, 2022). Mathematical literacy ability has five competencies that become student tools in various daily activities, namely mathematical problem solving competence, mathematical communication competence, mathematical reasoning competence, mathematical connection competency, and mathematical representation competence. (Kurnila et al., 2022). According to the 2018 PISA, based on

test and survey results, Indonesia was ranked 73 out of 78 countries evaluated for mathematical literacy with a score of 379. This shows a decline because in 2015 Indonesia was ranked 69 out of 76 with a mathematical literacy score of 386, so students' knowledge of mathematical literacy is still relatively low (Masfufah & Afriansyah, 2021).

The weak ability of students' mathematical literacy in Indonesia is because the questions taught do not provide problem-solving skills that require logical thinking (Natsir & Munfarikhatin, 2021). This is in line with the facts on the ground where the ability of high school students in the schools that the researchers used as research locations is still lacking in mathematical literacy skills which include communication skills, mathematical abilities, and in determining settlement strategies. The learning process in the classroom is more emphasized on results not on processes and the questions given are mostly not related to contextual problems so that students have not applied mathematics as a tool to solve them. In learning mathematics, students not only have the ability to count, but also must have the ability to reason logically in solving problems. The problem is not just a routine problem but a problem faced every day.

Relevant research related to mathematical literacy skills, material sequences and series, and problem based learning (PBL), namely, the first research on mathematical literacy skills through the PBL approach in 2022 that the use of the PBL learning model can further improve students' mathematical literacy compared to direct learning. Students who have a high portfolio percentage score of 28,125%, students who have a moderate portfolio percentage score of 56,25%, and students who have a low portfolio percentage score of 15,625%. This is because Problem Based Learning with Portfolio Assessment is an interactive learning model that starts with practical problems, involves and familiarizes students with the problem solving process, then builds knowledge through that process. The PBL model helps students maximize their problem-solving abilities, which may have implications for improving their mathematical literacy abilities (Kurnila et al., 2022).

Second, research on the effect of PBL on mathematical literacy skills in 2020 where the results of the study found that the overall effect size of applying PBL on students' mathematical literacy abilities was 0,830 with a standard error of 0,142. These findings indicate that the application of PBL in Indonesia is very effective because it has a high positive effect on increasing students' mathematical literacy abilities. Analysis of the level of variation across studies by considering the four moderator variables resulted in no change in the effect of using PBL on students' mathematical literacy abilities based on research publication sources (Q=7,571; p0,05) and sample size (Q=0,277; impact size.

These findings indicate that the PBL model is more effectively applied at higher levels of education.This fact contributes to the literature as a consideration for the application of PBL to future mathematical literacy skills (Paloloang et al., 2020).

Third, research on the effect of PBL on mathematical literacy skills in 2022 where based on the presentation in the study that from $tcount = 2.0533 > ttable = 2.0017$, the effect of the PBL model on the mathematical literacy abilities of TKR statistics students at SMKN 3 Bojonegoro . In addition, the results of the Mathematical Literacy Test for class XI TKR students at SMKN 3 Bojonegoro study statistics topics using the PBL model. And in this study the mathematical literacy abilities of class XI TKR students at SMKN 3 Bojonegoro who applied the PBL learning model were better than students who applied the direct learning model (Agustin & Mayasari, 2022).

Based on the results of several relevant studies related to mathematical literacy skills, problem-based learning, and sequence and series material, it focuses more on the subject of junior high school students, articles, and vocational high school students who discuss the application of the influence of learning models, but there is still little that relates it to analysis. Therefore the renewal of this research is to conduct research through analysis and the focus of the subject is high school students in class XI with the aspect being reviewed is the ability of mathematical literacy in the material for sequences and series. So, the researcher wants to take a research title, namely "analysis of students' mathematical literacy skills in sequences and series material through the application of problem based learning".

METHODS

The method used in this research is a qualitative approach with a qualitative descriptive method. Researchers used descriptive qualitative which aims to describe students' mathematical literacy abilities through the application of problem-based learning in solving problems, through direct observation of the completion process and achievement of indicators of mathematical literacy ability. In this study, the research subjects were students of class XI MIPA at one of the Jakarta State Senior High Schools. Tests, interviews, and document analysis of student learning outcomes were used as data collection techniques in this study. The research instruments were in the form of observation, tests of mathematical literacy skills on sequences and series material as well as interview guidelines. The interview used by the researcher is a semi-structured interview so that the information obtained is free and directed. The documents in this study are story

questions about sequences and series material compiled by researchers and the results of student work.

The data analysis techniques used in this research are data collection, data reduction, data presentation, and conclusions (Selan et al., 2020). Before the instrument was used, validation was carried out by the mathematics teacher and mathematics lecturer with the result that the instrument was suitable for use because it met the criteria in terms of content and language used.. The research phase begins with a grid of sequences and series. Then a mathematical literacy test is carried out for sequences and series material. The test is in the form of story questions related to sequences and series of 6 questions that have been validated. Then re-selection was carried out based on high, medium, and low scores, where a total of 36 students became 3 students who would be followed by interviews (Anggraini & Setianingsih, 2022). The guidelines for assessing mathematical literacy abilities used by researchers were adapted from aspects of mathematical literacy abilities (Simamora & Tilaar, 2021).

Table 1. Subject Coding

No.	Mathematical Literacy Ability Level	Subject
1	High	S1
2	Medium	S2
3	Low	S3

Table 2. Interval Score of Each Category

Category	Score Intervals
High	$\chi > 80$
Medium	$50 \geq \chi \leq 80$
Low	$50 < \chi$

Table 3. Grids of Test Instruments Describing Mathematical Literacy Abilities

Learning Achievement	Question Indicator	Mathematical Literacy Ability	Cognitive Level	Question Number
Apply arithmetic and geometric sequences and	Students can solve statements, questions, objects, pictures	Communication Skills	C4	1,2

Learning Achievement	Question Indicator	Mathematical Literacy Ability	Cognitive Level	Question Number
series, including problems involving single and compound interest.	of sequences and series (arithmetic and geometry).			
	Students can solve fundamental mathematical variables and structures in real-world problems related to single interest and compound interest.	Mathematization ability	C4	3,4
	Students can decide on strategies and apply facts, operations, algorithms, and structures in finding solutions related to sequences and series (arithmetic and geometry).	Ability to Choose Strategy	C5	5,6

Table 4. Story Problems Material Sequences and Series

No.	Question
1	A mother distributes candy to her 5 children according to the rules of a mathematical sequence. The younger the child, the more candy they get. If the number of candies received by the second child is 11 and the fourth child is 19. Determine the total number of candies.
2	The population growth of a city every year follows the rule of geometric sequences. In 1996 the increase was 6 people, in 1998 there were 54 people. Population growth in 2001 is.
3	Hana saves IDR 500,000 with a single interest of 5.5% which is paid every 6 months. What is Hana's savings balance if she withdraws the money after 42 months.
4	Rudi invests Rp. 25,000,000 in a cooperative at a compound interest rate of 8% per year. Determine how much money Rudi will have after three years.
5	In an arithmetic sequence, the sum of the 3rd and 5th terms is 14, while the sum of the first 12 terms is 129. If the nth term is 193, determine the value of n.
6	It is known that $\alpha, \beta, dan\ \gamma$ are respectively the 2nd term, 4th term, and 6th term of an arithmetic sequence. If $\frac{\alpha+\beta+\gamma}{\beta+1} = 4$, then the value of β is.

Table 5. Guidelines for Scoring Mathematical Literacy

Indicator	Criteria	Score	Maximum score
Solving and formulating problems	Able to identify and formulate problems appropriately	3	3
	Able to identify and formulate problems but the solution is not quite right	2	
	Not able to identify and formulate problems	1	
Using mathematization	Able to apply mathematical concepts or procedures and use precise formulas or arithmetic operations	4	4
	Able to apply mathematical concepts or procedures and use arithmetic formulas or operations but are not precise	3	
	Able to apply mathematical concepts or procedures and use formulas or arithmetic operations but are not precise	2	

Indicator	Criteria	Score	Maximum score
	and not in accordance with the problem		
	Not able to implement solving strategies and use formulas or arithmetic operations	1	
	Able to explain solutions and interpret conclusions appropriately	3	
communicate	Able to explain solutions and interpret conclusions but are not precise	2	3
	Unable to explain settlement and interpret conclusions	1	
	Total Score		10

Final Score = $\frac{total\ acquisition\ score}{maximum\ total\ score}\ x\ 100$

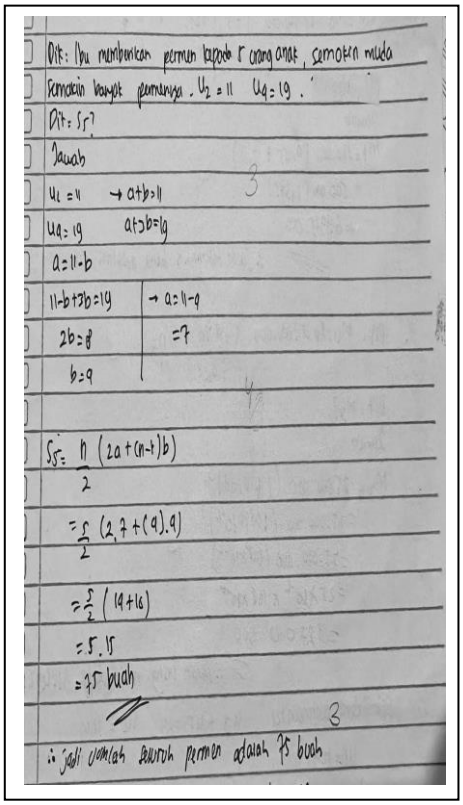
RESULT AND DISCUSSION

In this study, data were obtained in the form of test results, interviews, and documentation from 3 research subjects. Data analysis was carried out with aspects of mathematical literacy skills by looking at students' answers to questions about sequences and series through the application of problem-based learning. In the application of problem-based learning, students are given story questions related to everyday life. Student answers are assessed using assessment guidelines based on aspects of mathematical literacy ability.

Table 6. Scores of Students Mathematical Literacy Ability

Student Code	Question 1	Question 2	Question 3	Question 4	Question 5	Question 6	Total
S1	10	10	9	9	10	10	58
S2	8	8	8	7	6	3	40
S3	8	6	7	7	5	3	36

1. Subject 1 (S1)



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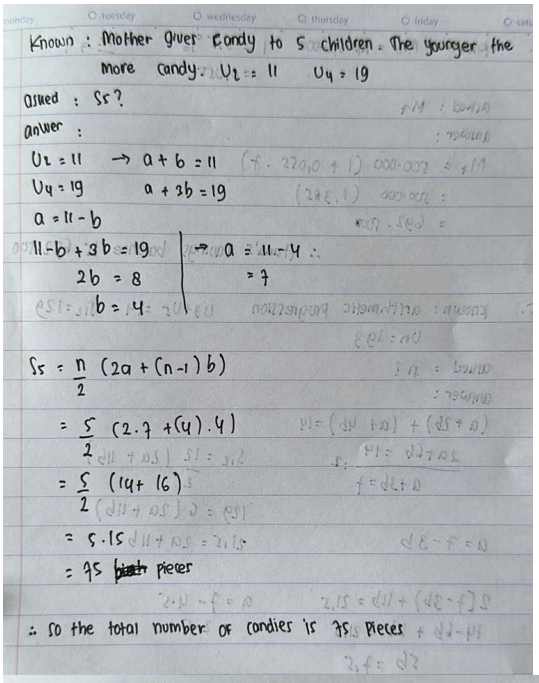

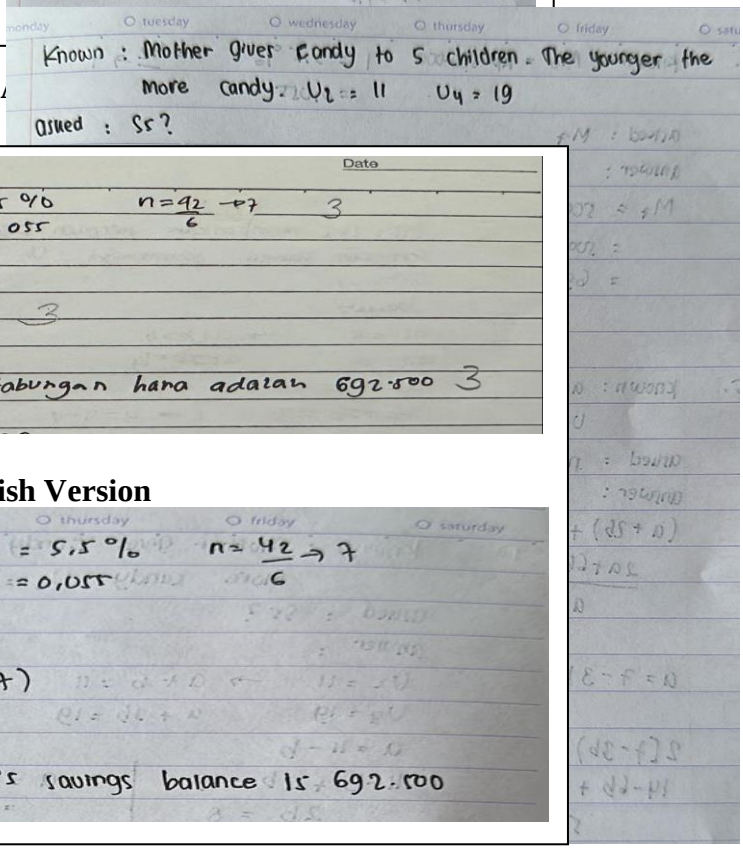

Figure 1. Results

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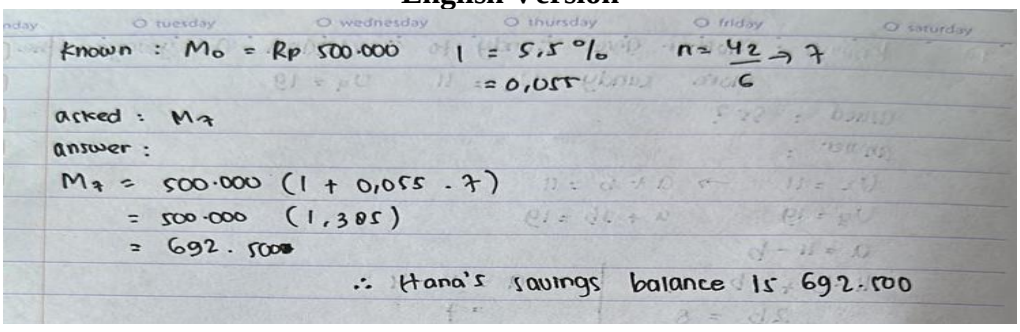
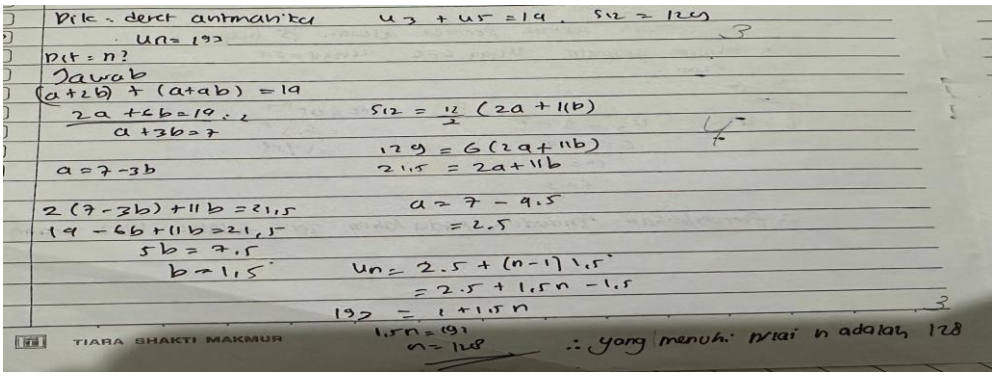


Figure 2. Result Answer Number 3



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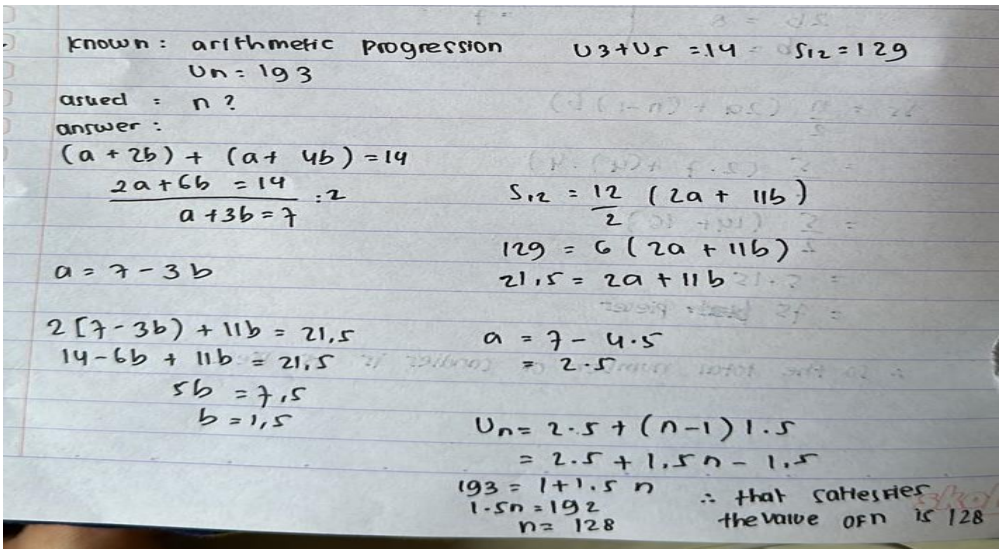


Figure 3. Result Answer Number 5

S1 interview results

Researcher : *"How do you respond after seeing related math problems given sequences and series?"*

S1 : *A little challenging.*

Researcher : *Are there any difficulties when you do math problems related to sequences and series?*

S1 : *Yes, because I forgot how to do it and the questions given were story questions, so it was a little difficult to understand the questions.*

Researcher : *How did you solve numbers 1 and 2?*

S1 : *Using the method taught, namely arithmetic series.*

Researcher : Is there another way to do questions number 1 and number 2?

S1 : Example answer no. 1 there is another way, if the 2nd child receives 11 candies while the 4th child has 19 candies, so 4 - 2 = 2 and 19 – 11 = 8 and 8 : 2 = 4 so 7 + 11 + 16 + 19 + 23 = 75.

Researcher : How did you solve questions number 3 and 4?

S1 : Using the formula previously explained, namely number 3 is single interest and number 4 is compound interest.

Researcher : Is there another way to do questions 3 and 4?

S1 : None .

Researcher : How did you solve questions number 5 and 6?

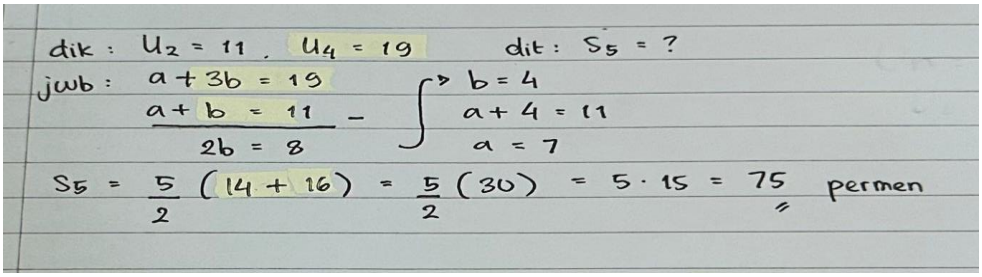
S1 : Using the formula that has been described previously.

Researcher : Is there another way to do questions number 5 and 6?

S1 : None.

Based on the results of S1 work, the subject was able to solve problems by applying problem-based learning. The subject was able to solve the problem by first writing down the information obtained and what was asked in the problem. The subject is able to interpret the problem correctly, the subject also knows the right formula for solving the problem and the subject interprets the conclusions from the answer. It can be seen that S1 is able to solve problems through the application of correct problem-based methods and S1 fulfills 3 indicators of mathematical literacy ability so that S1 is categorized as high mathematical literacy ability. This is the same as previous studies, namely students who belong to the high category are able to identify the problems they face, are able to identify what is known and what is asked in the questions clearly, precisely, and thoroughly (Muzaki & Masjudin, 2019)

2. Subject 2 (S2)



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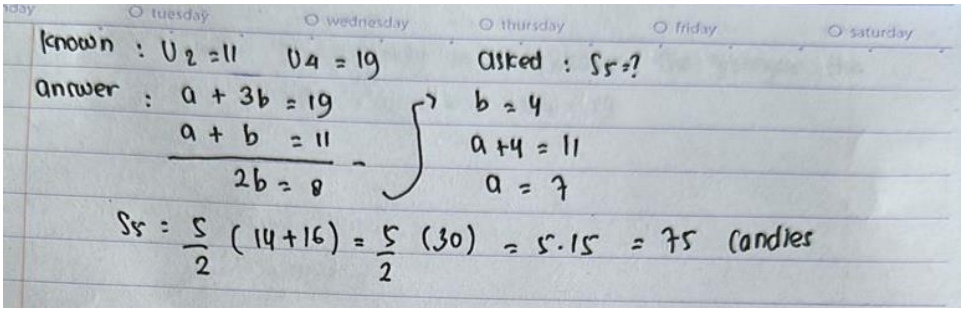
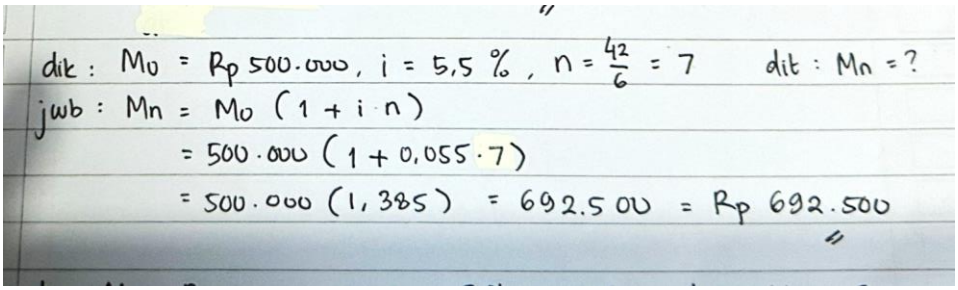


Figure 4. Result Answer Number 1



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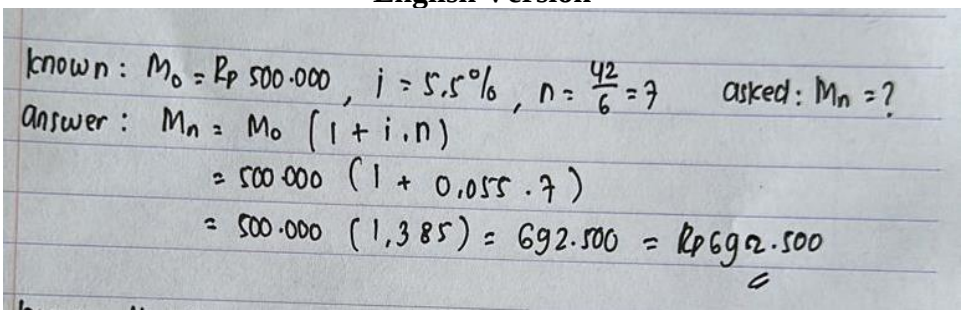
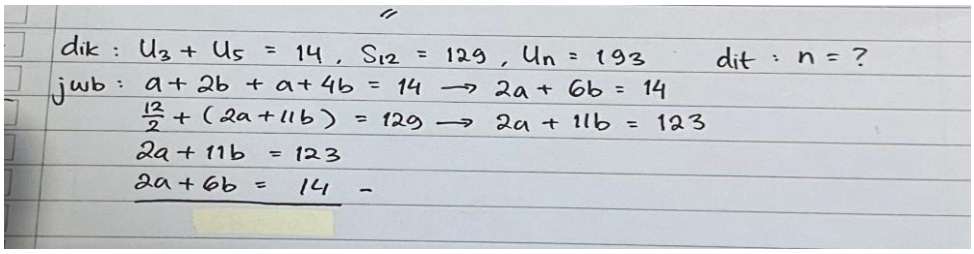


Figure 5. Result Answer Number 3



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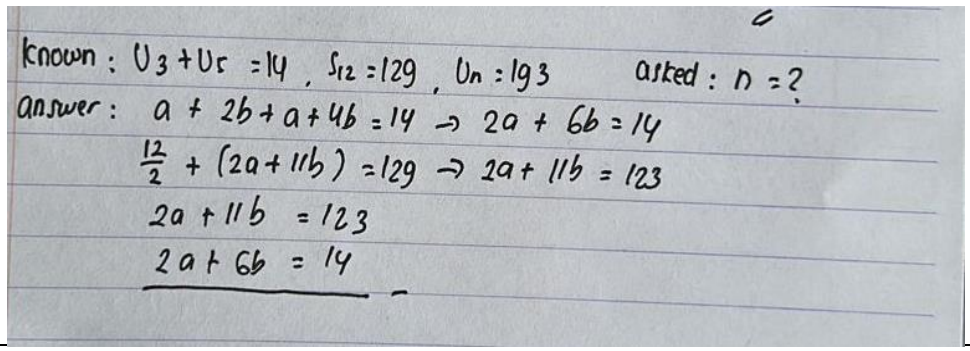


Figure 6. Result Answer Number 5

S2 interview results

Researcher : How do you respond after seeing the math problems related to the sequences and series that have been given?

S2 : At first the questions looked difficult because of the story questions, but when I already knew the formulas and tricks I was pretty good at solving the problems.

Researcher : Are there any difficulties when you do math problems related to sequences and series?

S2 : Yes, numbers 5 and 6 in my opinion are difficult because the way to do it is a bit long and quite complicated.

Researcher : How did you solve numbers 1 and 2?

S2 : By understanding the problem first and paying attention to what is already known in the problem, after that start working using the appropriate formula for number 1 using the arithmetic sequence and number 2 geometric sequence.

Researcher : Is there another way to do questions number 1 and number 2?

S2 : There is a possibility.

Researcher : How did you solve questions number 3 and 4?

S2 : *The same as numbers 1 and 2, namely by understanding the problem first and paying attention to what is already known in the problem, after that work on the problem according to the formula, namely number 3 is single interest and number 4 is compound interest.*

Researcher : *Is there another way to do questions 3 and 4?*

S2 : *It seems there is.*

Researcher : *How did you solve questions number 5 and 6?*

S2 : *For numbers 5 and 6 I forgot whether it worked until finished or not because as far as I remember there was not enough time so I immediately collected it.*

Researcher : *Is there another way to do questions number 5 and 6?*

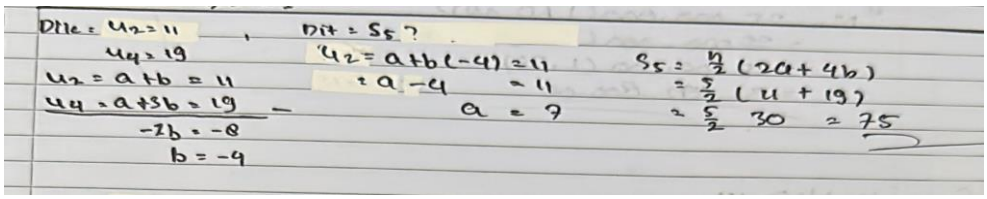
S2 : *It seems there is.*

Based on the results of working on S2 for question number 1 and 3 the subject was able to solve the questions by applying problem-based learning. The subject was able to solve the problem by first writing down the information obtained and what was asked in the problem. The subject is able to interpret the problem correctly, the subject also knows the right formula to solve the problem. For question number 5, the subject can write down the information obtained and what is asked in the problem, but the subject cannot solve the problem. Especially when working on difficult questions because the focus is divided because of being chased by time. Then the subject does not write conclusions at the end of the completion which includes indicators of mathematical literacy ability, namely communication skills. So it can be said that the subject can meet 2 indicators, namely mathematical ability and the ability to choose a strategy.

It can be seen from the method of solving S2, that the subject was able to solve the problem, but the subject had the reason that the time given was insufficient so that the subject felt unable to solve it. Even though the subject can solve several problem-based questions and can fulfill 2 indicators on literacy skills, the subject is said to have medium mathematical literacy skills because the results of the work on the questions are good enough. This is the same as previous research, namely students who are included in the medium category are able to interpret the questions correctly, students also know the correct formula, but

students are not able to apply the formula to solve the problem, because their focus is divided because they are being chased by time (Masfufah & Afriansyah, 2021).

3. Subject 3 (S3)



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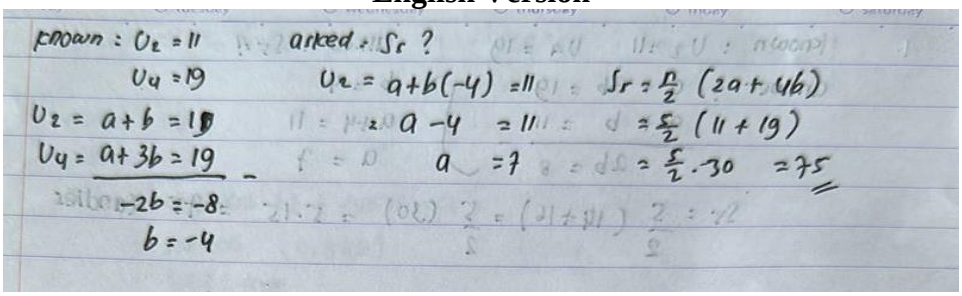
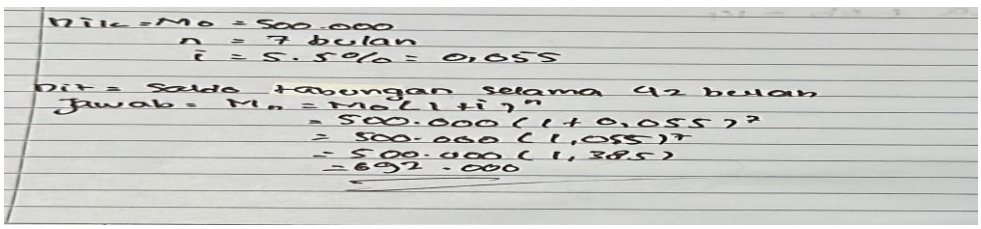


Figure 7. Result Answer Number 1



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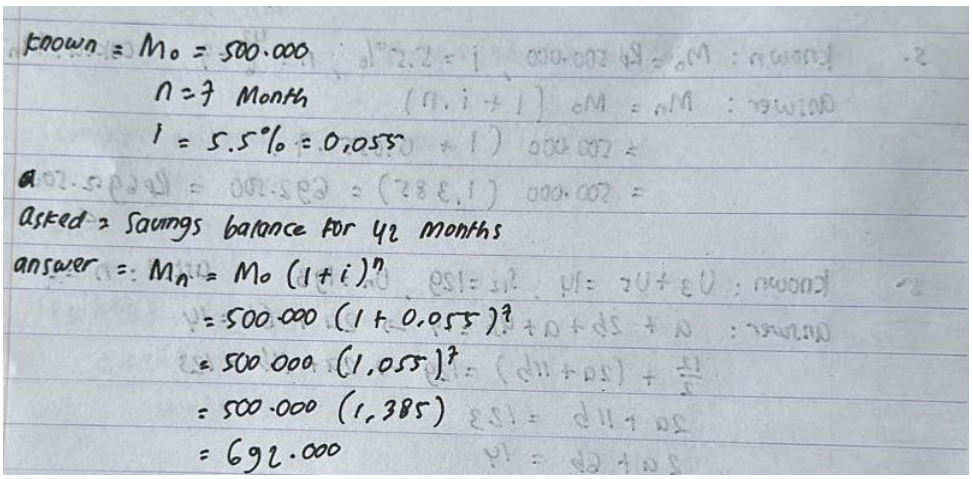
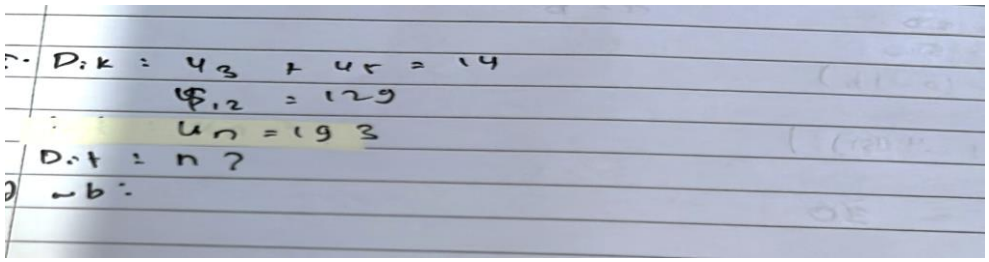


Figure 8. Result Answer Number 3



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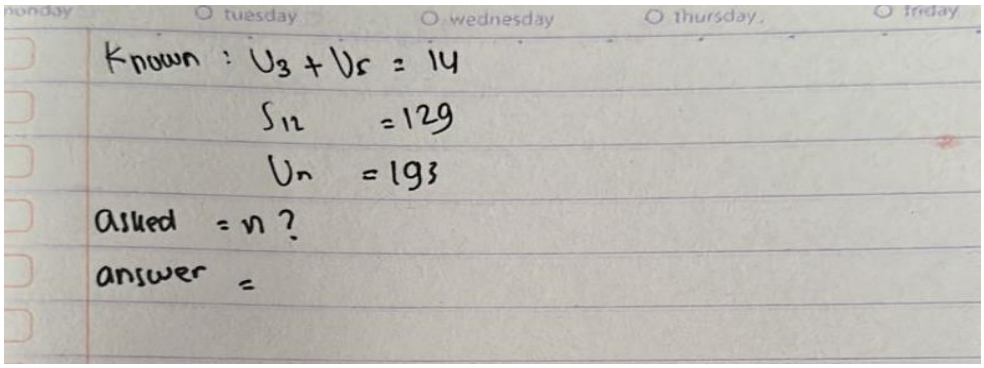

Figure 9. Result Answer Number 5

S3 interview results

Researcher : How do you respond after seeing the math problems related to the sequences and series that have been given?

S3 : A little difficult, but there are some things I can do.

Researcher : Are there any difficulties when you do math problems related to sequences and series?

S3 : Yes

Researcher : How did you solve numbers 1 and 2?

S3 : I use the arithmetic series formula for number 1 and for geometry number 2.

Researcher : Is there another way to do questions number 1 and number 2?

S3 : None.

Researcher : How did you solve questions number 3 and 4?

S3 : I use the formula previously explained, namely single interest and compound interest.

Researcher : Is there another way to do questions 3 and 4?

S3 : Maybe there is another way but I use the formula that has been explained.

Researcher : How did you solve questions number 5 and 6?
S3 : It's quite difficult, so I only write what is known in the problem.
Researcher : Is there another way to do questions number 5 and 6?
S3 : If you look at the questions, there might be because it looks like the method is long and uses 2 formulas.

Based on the results of working on S3 for question number 1, the subject was able to solve the questions by applying problem-based learning. The subject was able to solve the problem by first writing down the information obtained and what was asked in the problem. The subject is able to interpret the problem correctly, the subject also knows the right formula to solve the problem. For question number 3, the subject was able to write down the information obtained and what was asked in the question, but the subject made a calculation error which resulted in answer number 3 being wrong, but in the settlement operation there were no errors at all. Question number 5 the subject can write down the information obtained and what is asked in the problem, but is unable to apply the formula he knows to the solution he is working on, because he feels confused about how to use it. Then S3 does not write conclusions at the end of the completion which includes indicators of mathematical literacy ability, namely communication skills. So that it can be said that the subject only fulfills 1 indicator, namely the ability to choose a strategy.

This is the same as previous research, namely students who are included in the low category are only able to fulfill 1 indicator, namely the ability to choose a strategy and 2 other indicators, namely communication skills and mathematical abilities, are still lacking (Masfufah & Afriansyah, 2021).

CONCLUSION

Based on the results of the study it was found that the application of PBL to sequences and series material was able to achieve students' mathematical literacy skills because with PBL students were given statements or questions in the form of stories or existing cases. in everyday life so that it can hone literacy skills both in terms of communication skills, mathematical abilities, and the ability to choose strategies. However, there are still some inaccurate and unsystematic solutions, so that students' mathematical literacy abilities vary. Judging from their communication skills and mathematical abilities, students can solve problems systematically and correctly even though there are operations such as multiplication or addition of numbers or variables an error occurs and students from medium and low categories do not write conclusions at the end of the problem. From

the ability to choose a strategy students are able to identify the information contained in the problem, but students are not yet fully able to decide on a strategy and apply facts, operations and structures in finding solutions related to story problems in sequences and series material.

The researcher's suggestion for teachers is to teach students to solve problems systematically from any known information in the problem, what is asked in the problem, and answer questions both single questions and story problems and provide conclusions at the end of the completion. It is hoped that this research can be a reference for teachers in measuring as well as a reference in identifying students' mathematical literacy skills in story-shaped questions, both sequence and series material or other material. It is hoped that this research can also be used as a reference for further researchers who have relevance to this variable. limitations and deficiencies in this study should be used as learning for better research.

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