Profile of Middle School Students' Mathematical Literacy Ability in Solving Number Pattern Problems

Ronaldus Ariyanto Jelahu
Universitas Timor, Indonesia

Aloisius Loka Son
Universitas Timor, Indonesia

Hendrika Bete
Universitas Timor, Indonesia

Javier García-García
Universidad Autónoma de Guerrero, Meksiko

Sudirman
Universitas Wiralodra, Indonesia

Fiki Alghadari
STKIP Kusuma Negara, Indonesia

Abstract: The aim of this study is to describe profile of middle school students' mathematical literacy ability in Solving Number Pattern Problems. This study used a descriptive case study design with 29 students in grade VIII at a middle school in Kefamenanu city, Indonesia. Test and interviews were the methods to collect data about the mathematical literacy ability. To analysis data we used the Miles and Huberman models with stages namely reduction data, data presentation and conclusions as a technique. The results of the study concluded that the profile of middle school students' mathematical literacy ability in solving number pattern problems is in the high category. Students with high mathematical literacy abilities meet all indicators at 3 levels of mathematics literacy cognitive namely understanding level, implementation level and level reasoning. Students with medium mathematical literacy abilities were able to achieve indicators of the level of understanding, while for the level of application and reasoning not all indicators were achieved. Students with low mathematical literacy abilities are only able to reach the level of understanding indicators, while the level of application and level of reasoning has not been achieved.

Keywords: Ability, Mathematical Literacy, Number Patterns, Problems.

Correspondents Author:
Aloisius Loka Son, Universitas Timor, Indonesia
Email: aloisiuslokason@unimor.ac.id

Introduction

The quality of education is a benchmark for the quality of human resources to be able to compete in various aspects of life (Priyatna, 2016). One of the subjects that has an impact on education is mathematics. Mathematics is one of the subjects studied at all levels of education, which aims to achieve certain abilities in solving a problem. One of the abilities needed in learning math is math literacy.

Mathematical literacy is an individual's ability to use mathematics in various contexts. Habibi & Suparman (2020) revealeds that mathematical literacy refers to an individual's ability to formulate, use, and interpret mathematics in various contexts with mastery of information technology. However, Ojose (2011) defines mathematical literacy as the basic knowledge of mathematics that is used in everyday life. For its part, Kusumawardani, Wardono & Kartono (2018) stated that someone who has mathematical literacy ability will be aware of and understand mathematical concepts that are relevant to the problems they face.

Although mathematical literacy is one of the important abilities which must be owned by students, according to Hewi & Saleh (2020) the results of the PISA survey (Program for International Student Assessment) Year 2018 showeds that Indonesia is ranked 74 out of 79 countries participating in PISA, with an average score of 371, with an average OECD (Organization for Economic Co-operation and Development) score of 489. In the mathematics category, Indonesia won an average score of 379 with an average OECD score of 487. Furthermore, the results of the 2018 PISA show that only 1% of Indonesian students can reach level 5 in mathematics, which means that students have not been able to interpret mathematical abilities in everyday life in different contexts. On the other hand, the results of the Assessment Competency Minimum (ACM) of year 2021 showed that the ability of Indonesian students'mathematical literacy is still low (Pusmendik, 2022). In this sense less than 50% of students have achieved the minimum competence of mathematical literacy, meaning that most students have not reached the minimum competency limit, then it is said that students have limited knowledge of mathematics.

The report results from PISA are consistent with findings in the field, such as Azahra, Nurhanurawati & Caswita (2020) who showed that students completed the questions using routine procedures and command questions in an orderly manner live in quite good category, while they did not succed well for level 2 and level 3. Atsila & Setyawan, (2021) showed that the student's value in the numeracy test is still low with an average value of 26.65. The lowest score obtained was 17 and the highest score was 40, from the results of interviews with students it was known that when giving assignments, students only wrote the

final answers, so they were less able to analyze the questions independently. For its part, Rifai & Wutsqa (2017) stated that the mathematical literacy abilities of junior high school students in the Regency_Bantul categorized as low and very low. The proportion for the low category is 38.77% and the proportion for the very low category is 61.23%. In addition, Sudirman, et al. (2020) reported that the mathematical literacy of junior high school students is still low.

The results of previous studies are also consistent with the results of an interview with a junior high school mathematics teacher in Kefamenanu City. The results of the interviews indicated that students, who were given questions (description through assignments, repetition, or exam), many have not been able to understand the mathematical problems proposed. Students also have not been able to develop a problem-solving plan and have not been able to solve problems based on the plans that have been made. These defficulties are influenced by the low understanding, application and reasoning abilities of students in solving mathematical problems. The ability to understand, apply and reason is a cognitive aspect that is measured in the competence of mathematical literacy ability.

Based on the problems described, it can be said that the ability of junior high school students' mathematical literacy is still relatively low. It is supported by Ate & Lede (2022) which stateds that the mathematical literacy ability of junior high school students is still lacking and very lacking. Also conveyed by Fointuna, Kaluge & Fernandez (2019) that the literacy ability of junior high school students is generally included in the low category. Added more by Ibrahim & Zulfikar (2020) who indicated that the ability of students' mathematical literacy in one of the junior high schools in Kupang City is still relatively low.

The ability of mathematical literacy in this study is seen from the components of the cognitive level of mathematical literacy, namely the cognitive level of understanding, the cognitive level of application and the cognitive level of reasoning proposed by Pusmenjar (2021). One of the materials that can be used to reveal the 3 levels of mathematical literacy ability of junior high school students is to provide description questions on number pattern material. This material has the concept of questions that require students to have and choose the right strategy so that problems can be solved.

Mathematical literacy can facilitate students, especially middle school students, to be able to solve problems in various types of relevant contexts. In addition, mathematical literacy is essential in everyday life (Nurhanurawati, Caswita, Bharata, & Widyastuti, 2022) and be used in various contexts of personal life, social, and professional tasks (Straesser, 2015; Geiger, Forgasz & Goos, 2015). Thus, the aim of this study is to describe the profile of middle school students' mathematical literacy ability in Solving Number Pattern Problems.

Research Method

This research is a descriptive case study. This type is research that produces descriptive data in the form of written or spoken words from the people or observed behavior. This research was conducted in one of the junior high schools in Kefamenanu City, Indonesia, in the odd semester of the 2022/2023 Academic Year. Due to the aim of this research, the subjects in this study were 29 students of grade VIII middle school. Data collection techniques used were tests and interviews. Mathematical literacy ability test is carried out to obtain written data about the extent of students' mathematical literacy ability, while interviews are conducted to confirm the results of students' written tests.

The tests were organised based on the cognitive level of mathematical literacy ability, namely the level of understanding, the level of application and the level of reasoning with the composition of each item for each level. The indicators measured at the level of understanding are being able to retrieve or obtain information from figures, being able to classify numbers based on number and forms that have similar properties and are capable of performing effective algebraic procedures; at the level of application of the indicators measured include being able to find out the information contained in the problem proposed, being able to determine strategies and rules that are appropriate and efficient to solve real problems that can be solved using various methods, are able to apply or carry out strategies and operations to solve problems related to known mathematical concepts and procedures and are able to state results based on problem-solving operations and indicators at the reasoning level, namely analyzing information as an initial step in solving problems, capable think choose strategies and alternative solutions to solving problems and being able to make valid conclusions based on the results and facts obtained. The data analysis used in this research is model data analysis namely data reduction, data presentation and conclusion (Miles & Huberman, 1992).
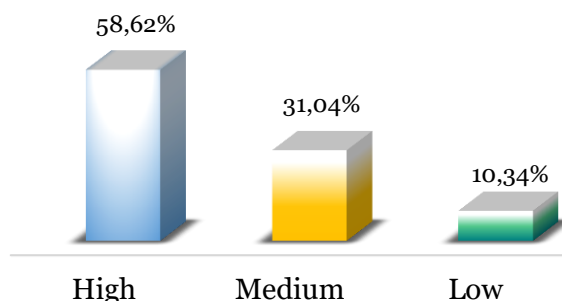
Profiles of students' mathematical literacy abilities are described based on high, medium, and low ability categories. The following is a table of student ability criteria according to Himmah & Sulasdini (2021) based on the results of the mathematical literacy test.

Table 1. Criteria of Literacy Mathematics Ability

Value	Description
$75 < X \leq 100$	Height
$50 < X \leq 75$	Medium
$\leq X\ 50$	Low

Result

The results of the mathematical literacy ability test allowed us to classificate the students for grade VIII junior high school in high, medium, and low groups just as we had considered. There are 17 students in the high category, 9 students in the medium category and 3 students in the low category (Figure 1).

Figure 1. Percentage of Students' Mathematical Literacy Ability Categories.

Figure 1 shows the percentage of mathematical literacy ability of students with high abilities was 58.62% of 29 students, the medium category was 31.06% and the low category was 10.34%.

Based on the criteria for mathematical literacy in table 1, the subjects selected to be interviewed based on the purposive sampling technique were LP subjects in the high category, GM in the medium category and RN in the low category. The following shows data on test results and interviews from students with high, medium and low abilities for number 1 the understanding level, number 2 the application level and number 3 the reasoning level.

High Ability Students

High ability subject test results (LP) for number 1, could be seen in Figure 2.

Figure 2. Results of Answers to Number 1 High Ability Students

To confirm the results of these answers, the researchers (R) conducted interviews with LP. The following is an excerpt of the researcher's dialogue with the student.

R   : What is known in question number 1?
LP : Sierpinski triangle, at level I = 1, level II = 3, level III = 6 and level IV = 10
R   : What was asked in question number 1?
LP : The number of black triangles in the fifth stage
R   : How do you determine the number of black triangles in the fifth stage?
LP : The pattern used is stage I plus 2 gets the result in the second stage which is 3, the second stage plus 3 gets the result in the third stage which is 6, the third stage plus 4 gets the result in stage 4 which is 10. Based on this pattern to answer what is asked on questions. So, the triangle at level IVplus with 5 up to 10 + 5 = 15 so the number of black triangles at the fifth level is 15 triangles.

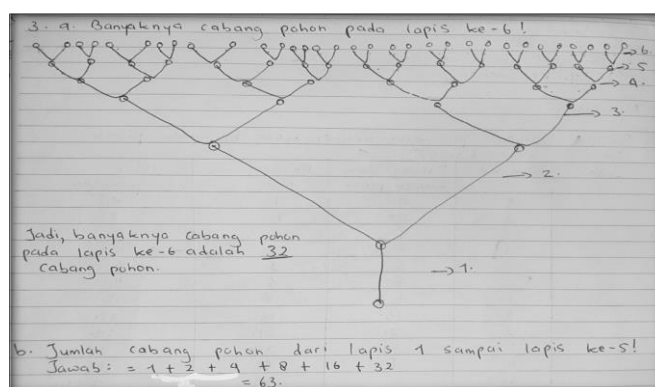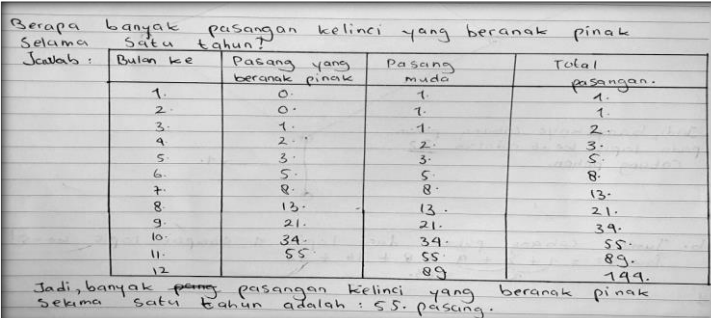High ability subject test results (LP) for number 2, can be seen in Figure 3.

Figure 3. Results answer number 2 student highly capable

To confirm the results of answer number 2, the researchers conducted interviews with student LP. The following is an excerpt of the researcher's dialogue with LP.

R   : What is known in question number 2?
LP : There is layer 1th = 1, layer 2th = 2, layer 3th = 4 and layer 4th= 8
R   : What is asked in question number 2?
LP : a. Lots of tree branches at tier 6th
       b. Number of tree branches from tier 1th to tier 5th
R   : How do you determine the number of tree branches in the 6th layer?
LP : To determine the number of tree branches in the 6th layer, I redraw the figures in the problem, then I continue the drawings for the 5th and 6th layers by following the previous model, after that I count the tree branches in the 6th layer. (While point to the figure on the answer sheet)
R   : How many tree branches are in the 6th layer?
LP : 32 tree branches
R   : How do you determine the number of tree branches from layer 1 to layer 5?
LP : By counting tree branches from layer 1 to layer 5th.
R   : How many tree branches from layer 1 to layer 5th?
LP : 31 branches.
R   : Why On the worksheet you answered 63?
LP : Because I was in a rush, it should only have reached stage 5 but Ith counted it to stage 6th.

High ability subject (LP) test results for number 3, can be seen in figure 4.

Figure 4. Results answer number 3 student highly capable LP

To confirm the results of answer number 3, the researchers conducted interviews with the student LP. The following is an excerpt of the researcher's dialogue with LP.

R : What is known in problem number 3?
LP : The number of pairs of rabbits that breed from the first month to the sixth month, the number of young pairs of rabbits from the first month to the sixth month, and the total number of pairs of rabbits from the first month to the sixth month.
R : What is asked in question number 3?
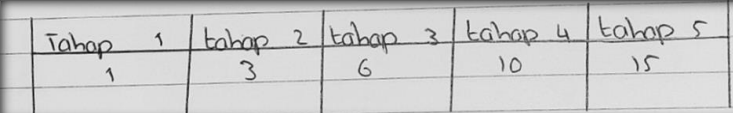LP : How many pairs of rabbits have litters in one year.
R : How do you solve question number 3?
LP : Using the table, the number of rabbit pairs that reproduce is calculated, namely the number of the first month plus the number of the second month, and so on until the twelfth month. So, the pair of rabbits that breed for one year is the number of pairs in the month twelfth, that is, 55 pairs.

Based on the results of tests and interviews on questions number 1, number 2 and number 3, it can be seen that LP is able to meet all indicators at the understanding level, application level and reasoning level.

Medium Ability Students

The results of the medium ability subject (GM) test for number 1, can be seen in Figure 5.

Figure 5. Results answer number 1 of students with medium ability

To confirm the results of the answers to question number 1, the researchers conducted interviews with the student GM. The following is an excerpt of the researcher's dialogue with the subject.

R : What is known in question number 1?
GM : Sum of triangles at level 1, level 2, level 3 and level 4.
R : How many triangles are there in each stage?
GM : Stage 1 = 1, Stage 2 = 3, Stage 3 = 6 and Stage 4 = 10
R : What is asked in question number 1?

GM : Look it up total black triangles on stage 5.
R : How to get the number of triangles on stage 5?
GM : Plus 1 + 2 = 3, 3 + 3 = 6, 6 + 4 = 10, 10 + 5 = 15, for each stage sequentially add up 2, 3, 4, 5.
R : What are the results?
GM : 15 triangles.

The results of the medium ability subject (GM) test for number 2, can be seen in Figure 6.

Figure 6. Results answer number 2 of students with medium ability

To confirm the results of answer number 2, the researchers conducted interviews with the student GM. The following is an excerpt of the researcher's dialogue with GM.

R : What is known in question number 2?
GM : What is known is the number of triangles Layer 1 = 1, layer 2 = 2, layer 3 = 4 and layer 4 = 8.
R : What is being asked?
GM : How many tree branches are in layer 6, and how many tree branches are from layer 1 to layer 5.
R : Why answer 12 for the 6th layer?
GM : I don't know sir, confused.
R : For question b?
GM : Confused sir.

The results of the medium ability subject (GM) test for number 3, can be seen in figure 7.

Figure 7. Results answer number 3 of students with medium ability

To confirm the results of the subject's written test, the researcher conducted an interview with the student GM. The following is an excerpt of the researcher's dialogue with GM.

R : What is known in question number 3?
GM : Rabbit pairs that reproduce for 6 months, young couples for 6 months and a total of 6 months of couples.
R : What is asked in question number 3?
GM : How many pairs of rabbits reproduce in 1 year. Q: How do you do it so that you get 55 pairs? GM: I don't know sir.
R : Why write answers like this?
GM : I don't know how it works sir. I just answered carelessly.

Based on the results of tests and interviews on questions number 1, number 2 and number 3, it can be seen that the GM was only able to fulfill all indicators at the understanding level, while the GM application level and reasoning level only achieved a few indicators.

Low Ability Students

The results of the medium ability subject test (RN) for number 3, can be seen in figure 8.

Figure 8. Results answer number 1 of students with low ability

To confirm the results of answer number 1, the researcher conducted interviews with the student RN. The following is an excerpt of the researcher's dialogue with RN.

R : What is known in problem number 1?
RN : Level I = 1, level II = 3, level III = 6 and level IV = 10.
R : What asked in question number 2?
RN : Find the number of black triangles in stage 5.
R : How do you determine the number of black triangles in the fifth stage?
RN : Number of stages to 4 with, 10 + 5 = 15.

The results of low-ability students' answers (RN) for number 2, can be seen in Figure 9.

Figure 9. Results answer number 2 of students with low ability

To confirm the results of the subject's written test, the researcher conducted interviews with the student RN. The following is an excerpt of the researcher's dialogue with the subject.

R : What information is contained in question number 2?
RN : I don't know sir.
R : Why answer 15 tree branches on the 6th layer?
RN : (does not answer).
R : Then why did you write this answer?
RN : I'm confused sir, I don't know how it works.
R : How about question part b?
RN : Confused sir (don't know)

The results of the low ability subject's answers (RN) for number 3, can be seen in figure 10.

Figure 10. Results answer number 3 of students with low ability

To confirm the results of the answers, the researchers conducted interviews with the student RN. The following is an excerpt of the researcher's dialogue with RN.

R : What is known in problem number 1?
RN : I don't understand.
R : What is asked in question number 1?
RN : How many pairs of rabbits have litters in one year.
R : Why write this on your answer sheet?
RN : Confused sir (don't know).

Based on the results of answers and interviews on questions number 1, number 2 and number 3, it can be seen that the RN was only able to fulfill the indicators at the understanding level, while the level of application and level of reasoning RN did not achieve all the indicators measured.

In addition, an analysis of students' mathematical literacy abilities based on high, medium and low categories is also shown in this section percentage achievement indicators at each cognitive level of mathematical literacy ability. Overall, the average score obtained by 29 students at the understanding level was 8.43, the application level was 8.86 and the reasoning level was 9.06. The average value of the total score is 75.74.

Percentage achievement of the cognitive level of understanding, application and reasoning can be presented in the Figure 11.
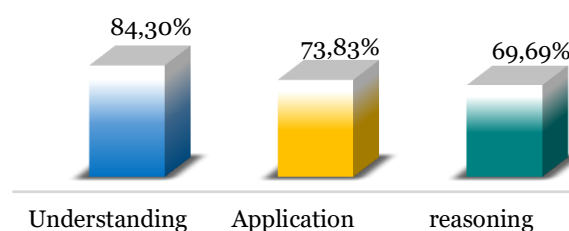

Figure 11. Chart achievement ability literacy mathematics on level cognitive

Figure 11 shows percentage achievement indicators of students' mathematical literacy ability at the understanding level of 84.30%, the application level of 73.83% and the reasoning level of 69.69%. The achievement of the indicator level of understanding is higher when compared to the level of application and the level of reasoning, and conversely the achievement of indicators of the level of reasoning is lower than the level of application of the level of understanding.

Discussion

Based on percentage achievement of the indicators and percentage in the category of mathematical literacy ability in Figure 1, it can be said that the mathematical literacy abilities of junior high school students in solving number pattern problems are in the high, medium, and low ability criteria. Students with high mathematical literacy abilities are able complete number pattern material questions by fulfilling all indicators measured at the cognitive level of understanding, cognitive level of application, and cognitive level of reasoning. This is supported by research results Maryati (2021) which states that the ability of students' mathematical literacy in the high category is able to solve the problems presented by fulfilling all the indicators that are measured. Added by Baharuddin, Jumarniati & Wahyuni (2022) which stated that subjects with high mathematical literacy ability were able to reveal all indicators of mathematical literacy. Even so, this group of high-ability students still experienced errors in solving level questions and reasoning, but this student gave an argument that he was actually able to solve it appropriately.

Students with medium mathematical literacy ability in solving number pattern material questions can achieve all indicators at the level of understanding because they are able to understand the problems informed in the questions. This is in line with Nasrullah, Ainol & Waluyo (2022) which states that students with medium numeracy abilities can understand and access information at the cognitive level of understanding questions. At the application level these students were able to achieve some of the indicators measured and some other students had notreach. At the reasoning level, students with medium abilities only achieve 1 indicator out of 3 indicators for reasoning levels. Students with medium mathematical literacy ability have relatively good mathematical literacy ability. It is supported by Maryati (2021) which states that students in the medium category generally have almost good mathematical literacy ability.

Research subjects with low mathematical literacy ability in solving number pattern material problems were only able to reach an understanding level indicator. Low category students have not met the indicators at the application level and reasoning level. It is supported by Lestari & Efendi (2022) who said that of the 4 mathematical literacy questions given, it was

found that students were only able to meet literacy indicators mathematics in question number 1, while questions number 2, 3 and 4 were not achieved. Added more by Tresnasih, Ratnaningsih & Rahayu (2022) that the subject of low mathematical literacy is only able to reveal 1 indicator, namely only indicator the first of the 3 indicators used.

In terms of students' mathematical literacy abilities, it was found that students who have good cognitive abilities will be able to achieve all indicators measured at the cognitive level itself. Students in the high category will have superior mathematical literacy abilities compared to students in the medium and low categories, students in the medium category have slightly superior mathematical literacy abilities than students in the low category.

Conclusions

Based on the results, it was concluded that the profile of students' mathematical literacy abilities at one middle school in Kefamenanu city in solving number patterns problems is in the high category. Students with high mathematical literacy ability fulfill all indicators at 3 cognitive levels of mathematical literacy, namely understanding level, application level and reasoning level. Students with medium mathematical literacy ability are able to achieve all indicators of understanding cognitive level while for the cognitive level of application and reasoning not all indicators are achieved. Students with low mathematical literacy ability are only able to achieve indicators of the cognitive level of understanding, while all indicators at the cognitive level of application and cognitive level of reasoning are not achieved.

Recommended to teachers train students more often in solving questions that require students to be able to understand, apply and reason in solving mathematical problems. For future researchers who wish to conduct research on mathematical literacy ability, they should use a more complete cognitive level.

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