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Assessing numeracy skills on flat shapes and scaffolding forms in junior high school

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ABSTRACT

Based on The Regulation of The Minister of Education, Culture, Research and Technology No.17 of 2021, cognitive learning outcomes consist of literacy and numeracy as measured through a minimum competency assessment (MCA) with grade 5, 8, and 11. The subjects in this study are 42 students of grade VIII (second grade) from state Junior High School 4 Cirebon and State Junior High School 2 Cirebon, Indonesia. The instruments were tests of numeracy literacy skills, documentation, and interviews. Purposive sampling was used to determine the subject of analysis of test results and interviews. The data were analyzed descriptively through the following stages: data reduction, data presentation, and conclusions drawing. The results showed that the research subjects are still not familiar with numeracy literacy questions which have the characteristics of always being preceded by texts, not understanding what is known and asked in the questions so they tend to blindly guess the answers and needed to be reminded of the prerequisite material. Based on the results of this study, teachers can develop learning media, project-based learning, scaffolding, and teaching materials that accommodate numeracy skills or differentiated learning.

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1. INTRODUCTION

The golden generation, a manifestation of human resources with good integrity, character as the Indonesian nation, and competence in their fields are Indonesia's target when they reach the age of 100 in 2045. To realize this dream, Indonesia with its productive human resources, must be managed properly so that it can accelerate the country's development. The mismanagement of human resources will become a burden on the country [1]. Indonesia, with extraordinary modalities, especially in the human resources sector, must be equipped with the ability to think and reason in solving problems. This is in line with the opinion [2] which states that the ability to think and reason is needed in solving problems. Both abilities are related to literacy skills. There are six basic literacy skills that must be mastered: numeracy literacy, scientific literacy, media literacy, financial literacy, and cultural literacy [3]. This research mainly focuses on numeracy literacy.

Numeracy literacy skills are very important in both work and daily life [4]–[6] so they are one of the abilities that must be developed in the 21st century [7]. Numeracy literacy is seen by several countries as the foundation to be able to survive in the era of technological transformation and the current pressure of globalization [8]. Therefore, there are major initiatives from several countries to improve these two skills by integrating them into the education curriculum, to reduce the marginalization of individuals in the workforce and other forms of social crime [8]. The curriculum is designed to enable students to acquire knowledge, concepts, skills, and values that are relevant to life today and in the future. In 2011, the National Council for Curriculum and Assessment (NCCA) directed each school to prioritize literacy and numeracy by subject, using part or all of the curriculum time to develop literacy and numeracy [9].

Literacy is defined as the ability to read effectively, synthesize information, and be able to draw high-level conclusions from reading texts related to everyday life [10]. Literacy can also be interpreted as a person's capacity to understand, use, and reflect on written texts, as well as develop knowledge and potential to participate in society [11]. In a narrow sense, literacy is defined as the ability to read and write, while in a broad sense, literacy consists of the ability to speak, listen, and think critically by reading and writing, using and understanding mathematical concepts and notations, computer literacy and emphasizing the ability to derive acquire from texts [12]. Literacy development contributes to the formation of a person's way of thinking by integrating traditional and intellectual knowledge so that it will be following certain cultural, communicative, and ideological environments [13]. From several studies, it is concluded that literacy is the ability to read, use written information, and write accurately about a context/text material, as well as an understanding of numbers and mathematical symbols that are always developing and used in social life.

If literacy is said to be the main key to participation in social life, then numeracy is often considered an equally important secondary role in life and requires the same attention to be developed [14]. The development of literacy and numeracy is interrelated [15] and interdependent [16]. The findings of Program for the International Assessment of Adult Competencies (PIAAC) and Program for International Student Assessment (PISA) show a strong relationship between literacy and numeracy [16]. Furthermore, a person with a low number will have an impact on overall well-being, standards, and quality of life [17], [18]. Numeracy comprises a wide range of skills from basic arithmetic and logical reasoning to advanced mathematics and interpretive communication skills [11]. Numeracy is the ability to acquire, interpret, use, communicate, and involve mathematical information and ideas in various situations in real life [19]. Numeracy involves knowledge, computational thinking, skills, behavior, confidence, and disposition to use mathematics in working with numbers and measures [20]. Numeracy is seen as a domain in the mathematics curriculum (linked to each other), but numeracy and mathematics are not the same [14]. Mathematics is a discipline that has many branches, both applied and theoretical, where numeracy skills serve every branch of science [20]. Both numeracy and mathematics are based on the same knowledge and skills, but the difference lies in the empowerment of this knowledge and skills [21]. Knowledge of mathematics alone does not automatically make a person have numeracy skills [22]. Numeracy includes the skills to apply mathematical concepts and rules in real everyday situations (contextual) [23]. Unstructured contextual problems often have many ways of solving, or even no complete solution, and are related to non-mathematical factors [24]. The relationship between numeracy and mathematics is described in the Figure 1.

Numeracy requires mathematics which is a branch of accurate knowledge that systematically includes rules, concepts, reasoning processes, and abstract structures. The implementation component of numeracy cannot be separated from the content of mathematics education [25]. Numeracy elements are growing day by day; currently, numeracy literacy is divided into four elements which include numbers, measurement and geometry, algebra, and data processing [26]. Based on the results of the minimum competency assessment (MCA) carried out by the Ministry of Education and Culture (MoEC) which measures literacy and numeracy skills [27], in the city of Cirebon, which was attended by 70 high schools/equivalent with 2,048 students obtained the results that less than 50% of students have reached the minimum competency limit for numeracy. The results of the MCA in 2022 can be seen in Figure 2.

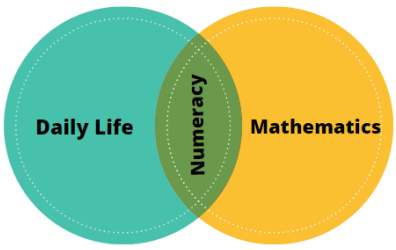


Figure 1. Numeracy and mathematics

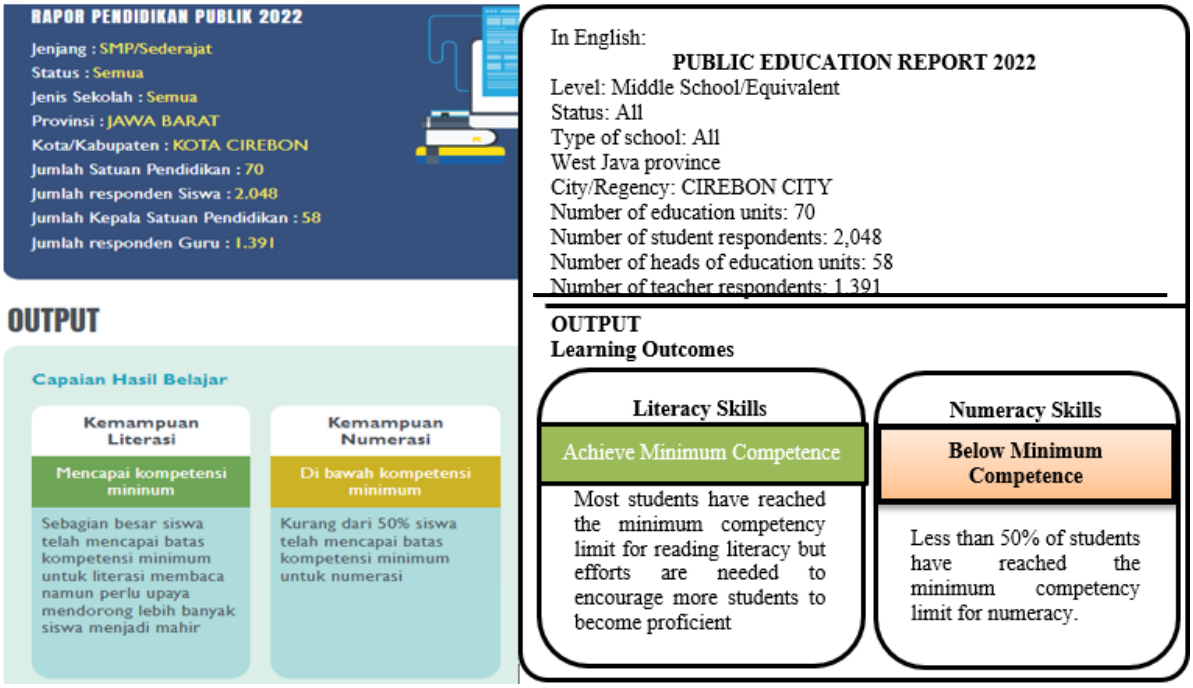


Figure 2. Report of high school student numeracy assessment in Cirebon city in 2022

Furthermore, Indonesia obtained a mathematics score of 379 with an average participant score of 489 in the 2018 PISA. The results of the test show that Indonesia has not been able to occupy a good position. Indonesia is far below China which received an overall score of 591 [28].

Yalcin *et al.* [29] stated that, international scale evaluation is an important indicator as a reference to improve a country's education system. The causes of the low PISA scores as a reference for numeracy skills include the lack of ability to understand questions in contexts that include real everyday problems. Therefore, it is necessary to introduce numeracy literacy to students as early as possible. It is in line with the opinion of [30] which states that numeracy literacy must be introduced to support students thinking skills.

To help students who, have difficulties in solving literacy and numeracy problems, appropriate learning aids or scaffolding are needed. The improvement of this thinking structure is based on the belief that when students are in the zone of proximal development (ZPD), students have the potential to develop optimally. Scaffolding reflects Vygotsky's notion of ZPD which describes the gap between what students achieve on their own and what can be achieved with mentoring [31], [32]. Therefore, teachers must pay attention to the problems of each individual before providing scaffolding [33].

Several studies related to the assessment of numeracy literacy skills have been carried out. have identified the patterns of reflective thinking processes of junior high school students, considering their cognitive styles, when solving numeracy problems in the number content [34]. Tout and Gal [35] examined the conceptual framework that aims to explain the similarities and differences between the construction of numeracy literacy and mathematics. Pangesti [36] has conducted research related to developing numerical literacy in mathematics learning with HOTS questions. Purpura and Lonigan [37] developed a valid, reliable, and brief numeracy assessment for children aged 3 to 5 years old, involving 393 participants. Several researchers [38], [39] have conducted research related to the numerical ability profile of high-ability in junior high school in solving mathematical problems. However, research that analyzes the numeracy literacy ability of junior high school students and the form of scaffolding has never been done. Scaffolding given to students with numeracy abilities in the high, average, and low groups will certainly be different.

Based on this rule, the researchers are interested in analyzing in depth the numeracy literacy abilities of grade VIII (second grade) students on the area and perimeter of flat shapes (rectangles), especially in groups of students with medium and low abilities. The material for the area and perimeter of flat shapes was chosen because it is the basic material for studying other flat shapes [40]. Therefore, the purpose of this study was to explore the numeracy literacy ability of grade VIII students in solving mathematical problems on flat shapes. Knowing the thinking patterns of students' numeracy can help teachers in preparing appropriate models, methods, strategies, or learning tools to improve their numeracy skills.

2. RESEARCH METHOD

This research is descriptive qualitative research that aims to reveal the numeracy thinking process of grade VIII (second grade) students and its scaffolding form. This research took place at State Junior High School 4 Cirebon and state Junior High School 2 Cirebon from June until July 2022. The subjects of this study were 42 students who were then grouped into three categories based on early mathematical ability (EMA). Purposive sampling was used, namely by taking samples based on certain considerations [41]. Data collection was done by analyzing student assignments that have been given by the teacher and later grouping students based on mean ideal (MI).

The subjects consisted of two students who were in the high group, two students in the average group, and two students from the low group. Each subject was interviewed by researchers about the tasks they have done based on indicators of numeracy literacy ability. Indicators of numeracy questions in research include using various kinds of numbers and symbols related to basic mathematics to solve practical problems in various contexts of daily life, analyzing information displayed in various forms (graphs, tables, and charts), and using the interpretation of the results of the analysis to predict and make decisions. As for the numeracy literacy questions on the area and perimeter of flat shapes, the quality of the questions has been tested with validity, reliability, discriminating power, and difficulty index as explained in the subsequent text.

Type 60 house is a type of house that is neither big nor small. In other words, the type 60 house has quite ideal size. Type 60 is a type of house that is classified as average and very suitable for a family. As the name implies, a type 60 house is a house with an area of 60 m^2. Even so, the size might differ because, in some conditions, there are also differences in length and width sizes. In addition to 6×10 m^2, the 8×7 m^2, and 6×12 m^2 are also included in the type 60 house. With these differences in size, you can choose a type 60 house with a size that suits your needs. Based on data from a home developer company, the minimum size of each ideal room for the family is shown in the Table 1.

Table 1. The type 60 house ideal size

Room	Length (m)	Width (m)
Main bedroom	4	3
Children bedroom	3	3
Guest bedroom	3	3
House assistant bedroom	3	2
Living room	5	3
Dining room	3	3
Kitchen	3	3
Garage	5	3
Bathroom	2	2
Toilet	3	1
Storage room	3	2
Prayer room	3	2
Terrace	3	1
Staircase area	2	1
Backyard	3	1

Even though it does not have to be the same because it relates to the condition of the land, the example can at least be an illustration for us for planning or deciding to build a house with an ideal size that can be inhabited by several people. Mr. Darto plans to build a house that will be shared with his wife and child. The criteria for the house that Mr. Darto wants to build are: i) Mr. Darto does not have a house assistant so he does not make a room for a house assistant; and ii) Mr. Darto will not have a guest room. Pay attention to the following problems: First, Mr. Darto bought a plot of land with an area of 1 acre and allocated 3 m^2 of the land for a garden. Can Mr. Darto build an ideal house with type 60? Give your explanation along with the calculations used! Second, make a plan for Mr. Darto's house that meets the criteria for the house above.

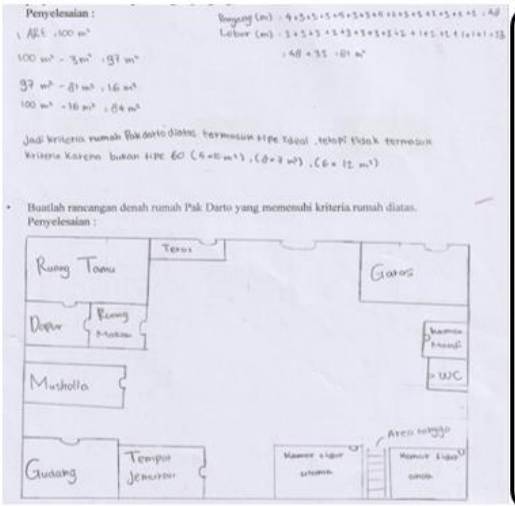
The instruments in this study were the researcher, interview guide, and numeracy literacy test. The two instruments have been validated constructively and contented by experts through the forum group discussion (FGD). The data analysis technique goes through three stages explained by Miles and Huberman [42], namely: i) data reduction; ii) data presentation; and iii) conclusion. The test results were analyzed using qualitative data analysis based on the process of numeracy kills.

3. RESULTS AND DISCUSSION

Numerical literacy is closely related to solving mathematical problems. Without problem-solving the benefits of learning mathematics are limited. Solving the problem in question is not a routine but rather finding solutions to contextual problems faced daily.

3.1. Numeracy literacy problems in flat shape materials

Researchers analyzed the results of student assignments based on indicators of numeracy literacy skills and nine people were taken to be research subjects. Subjects were taken based on different groups of EMA, namely the high (H), average (A), and low (L) groups. The results of student answers in the category of moderate ability students can be seen in Figure 3.



In English:

- Mr. Darto bought a plot of land with an area of 1 acre and allocated 3 m^2 of the land for a garden. Can Mr. Darto build an ideal house with type 60? Give your explanation along with the calculations used!

Answer:
Length=4+3+3+3+5+3+3+5+2+3+3+3+3+2+3=48 m^2
Width=3+3+3+2+3+3+3+3+2+1+2+2+1+1+1=33 m^2
= 48+33=81 m^2
1 Are=100 m^2
100 m^2 – 3 m^2=97 m^2
97 m^2 – 81 m^2=16 m^2
100 m^2 – 16 m^2=84 m^2
So the criteria for Mr. Darto's house above are the ideal type.
But not including 60 type (6 x 10 m^2) (8 x 7 m^2) (6 x 12 m^2)

- Make a plan for Pak Darto's house that meets the criteria for the house above.

Figure 3. Students' answers to question number 1 in the medium category

In Figure 3 for question number 1, as many as 8 students answered correctly and 34 others answered incorrectly, while for question number 2, as many as 42 students answered incorrectly. Based on the results of the analysis of student answers and in-depth interviews, from the two questions, it was revealed that the thinking process and the structure of the problem were incompatible. This incompatibility can be seen in the Figure 4.

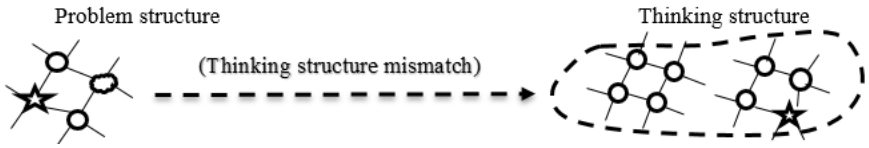


Figure 4. Illustration of incompatibility of thinking structure

To get the student's thinking process, the researcher conducted in-depth interviews. Based on the interviews, the following dialogues with students 1 (S1) were recorded by the researcher (R).

S1 : For question 1, we have to find the area, so we have to find the length and width. 1 acre equals 100 m^2, the garden will be 3 m^2 and the total (pointing to the length and width) what's left is 16 and it's in the ideal category, ma'am.
R : If you compute the length and width, what you're looking for is the area or the parameter?
S1 : Area ma'am, eh wait…is it? I'm confused ma'am.
R : Okay, why is there an empty room in picture 2?
S1 : I don't know how to decide the measurements ma'am.
R : If you want to find out the area of each room, for example, this living room, (pointing to the picture) then what formula will you use?

S1 : Rectangular, ma'am.
R : How to find out the area of rectangular?
S1 : Length times width.
R : That's right, then why did you compute all the lengths and widths of all rooms?
S1 : Ahh that's right, I should've multiplied it first then add.
R : Right, you should've found the area of each room first.

Based on the results of the interview, students experienced confusion in distinguishing between area and perimeter. This had an impact on question number 2, which was to represent the room arranged in the form of a table into a house plan.

3.2. Suggestions for increasing numeracy literacy towards the scaffolding

To help students with difficulty in developing literacy and numeracy thinking, appropriate learning aids or scaffolding are needed. The improvement of this thinking structure is based on the belief that when students are in the ZPD, students have the potential to develop optimally. Scaffolding reflects Vygotsky's notion of ZPD which describes the gap between what students achieve on their own and what can be achieved with mentoring [31], [32]. Therefore, teachers must pay attention to the problems of each individual before providing scaffolding [33].

Several types of scaffolding can be used separately or in combination [43] including conceptual scaffolding, verbal scaffolding, visual scaffolding, and decision-making scaffolding. Teachers can choose the form of scaffolding according to the characteristics of the learning material. The form of scaffolding in general can be in the form of printed teaching materials, interactive teaching materials, learning media, and so on [44]. Based on the results of the identification of numeracy problems in the average and low categories, the researchers then formed a scaffolding area and perimeter of a rectangle shape which can be seen in Figure 5.

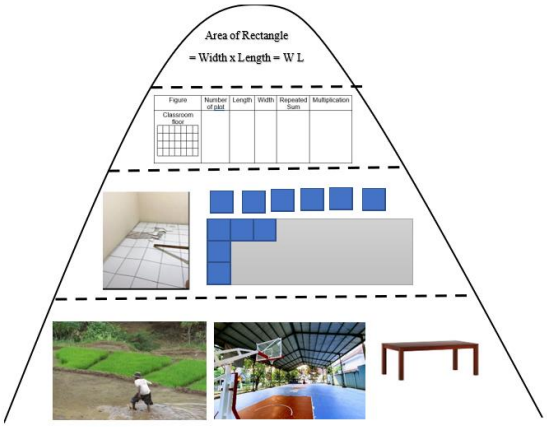


Figure 5. Ice berg of rectangular area

In Figure 5, the rectangular area scaffolding begins by showing the implementation of the rectangular area in daily life, such as the area of the rice field, the area of the basketball court, and the surface area of the table. Furthermore, from some of these explanations, students were given an understanding of the area of a rectangular area with a unit square approach. Through the real action of measuring the floor of the classroom, students are expected to be able to arrange a unit square from the tiled floor to find its area. In the final stage, students can find a formal model for finding the area of a rectangle equal to the length times the width. Each student can be given the scaffolding according to their respective abilities.

In Figure 6, the rectangular perimeter scaffolding begins by showing the implementation of rectangular perimeters in everyday life, such as fences, running tracks, street, and lights. Furthermore, from some of these explanations, students were given an understanding of the perimeter of a rectangular area. Through the real action of measuring the perimeter of the field, students are expected to be able to determine the length and width to find the parameter. At the final stage, students can find a formal model for finding the perimeter of a rectangle=2×(Length+Width). Each student can be given the scaffolding according to their respective abilities. Furthermore, the application of scaffolding with reflective activities in the matter of numeracy will be presented in the Table 2.

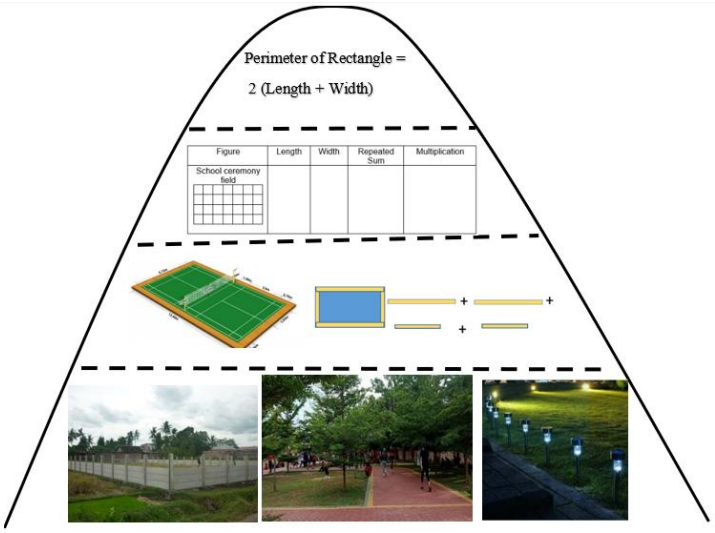


Figure 6. Ice berg around the rectangle

Table 2. Application of scaffolding in numeracy problems

Teacher's strategy	Expectation of student activity
Encourage students so they can: a. Identify problems. b. Connect the concept of the area and perimeter of flat shapes with everyday events. c. Make a representation of the concept into figures, graphs, tables, and sentences. d. Compare the arrangement of the concept of area and perimeter of flat shapes produced in groups.	Students can: a. State what is known, asked and related. b. Have a problem-solving plan or strategy. c. Make a figure according to the numeracy problem, namely by making a house plan. d. Write down the discussion results.
Encourage students so they can: a. Connect the concepts of area and perimeter of flat shapes with their measurements. b. Connect the concepts of area and perimeter with algebra. c. Connect the concept of area and perimeter of flat shapes with Pythagoras.	Students can: a. Solve problems involving the area and perimeter of flat shapes with their measurements. b. Solve problems involving the area and perimeter of flat shapes with algebra. c. Solve problems involving the area and perimeter of flat shapes using Pythagoras
Encourage students so they can: a. Design several hypotheses/conjectures. This is done to convince students in taking a problem-solving plan. b. Describe the reasons underlying the correct solution. c. Use various ways to solve numeracy problems. d. Draw conclusions.	Students can: a. Discuss several plans or alternative problem-solving in their respective groups. b. Explain the reasons underlying the solution. c. Write down various solutions. d. Write conclusions.
Encourage students so they can: a. Actively gain new knowledge by integrating previous knowledge. b. Active in checking every step of problem-solving.	Students can: a. Build new knowledge by integrating previous knowledge. b. Detect if there is an error in determining the answer.

3.3. Discussion

Based on the results of students' answers in working on numeracy questions on the area and perimeter of a rectangle and interview quotes, students experienced confusion in distinguishing between area and perimeter. This result is in line with previous researchers [45], [46] who stated that students lack a conceptual understanding of area and perimeter and have a wrong understanding of the relationship between the two. This had an impact on question number 2, which was to represent the room arranged in the form of a table into a house plan. If the broad concept is not well understood, students will have difficulty representing it in the form of figures.

The results of previous study [47] showed that grade VIII (second grade) students with low ability levels were unable to explain and distinguish the concepts of the area and perimeter of a geometric shape. They were only able to answer the definition and types of triangles. Likewise, with a parallelogram, some of the mistakes made by students include not understanding the concept of the properties of a parallelogram, students not understanding that the base and height of a parallelogram are perpendicular to each other, the

concepts of area and perimeter, and the concept of a parallelogram which image is combined with other flat shapes [48]. Based on the results of previous study [49], junior high school students found many obstacles in the visualization of questions of combined flat shapes. Difficulties in studying the area and perimeter of flat shapes are also caused because students that only memorize the formula without understanding it [50]. Therefore, teachers must be able to create meaningful learning [51], [52] by ensuring that students understand the concepts and how to apply them in everyday life and not just recite it [53].

Meaningful learning can be built through activities that involve students interacting with information and communication technology (ICT) [54], [55], direct models, concrete objects, or any object that is familiar and related to students' real experiences. An example of meaningful learning that can improve numeracy literacy skills is through projects [56]. Project-based learning on the area and perimeter of a rectangle in this study began with its use in everyday life. Furthermore, from these events, students were given an understanding of the perimeter and area of a rectangle. Through real actions of measuring the perimeter of the field and counting the number of floors in the classroom, students were expected to be able to determine the length and width to find the area and perimeter. In the final stage, students were expected to be able to find a formal model and connect it to several other mathematical concepts such as measurement, algebra, and Pythagoras. These concepts cannot be connected or understood properly, one part of the concept is ignored [57].

Numeracy literacy skills require high mathematical logical abilities. This is in line with Booth and Thomas [58] who stated that individuals who have high mathematical logical abilities can answer mathematical problems using numbers or basic mathematical symbols, identify graphic data in the form of tables or charts and use them for solving relevant problems. Based on this opinion, mathematical knowledge and the ability to operate numbers may be possessed, but when interpreting mathematical rules in a real phenomenon and relevant problems are irregular, sometimes very little attention is paid. Individuals who have various insights related to mathematics, do not guarantee that the individual has good numeracy skills.

To improve numeracy literacy skills, teachers must be able to identify, provide numeracy questions and design the right scaffolding [59], [60]. Therefore, the teacher must first diagnose the difficulty. By knowing the student's difficulties, the teacher can use this as a reference to improve the planning and implementation of the next lesson. The recommendations in this study are different from those of previous researchers in Indonesia. Andika *et al.* [61] explained that students' self-concept will support students' numeracy skills through board game activities. This is confirmed by Samad *et al.* [62], that traditional games can improve students' numeracy skills. Prabowo *et al.* [63] applies learning lessons in learning to improve students' numeracy skills. In addition, multimedia-based games can support children to develop numeracy skills [64]. This research is limited to designing scaffolding on the area and perimeter of a rectangle. Further research can develop learning tools with scaffolding strategies and determine their effectiveness in the classroom.

4. CONCLUSION

Based on the results of research and discussion, students in the low and average groups have not mastered numeracy well. They are not able to use various kinds of numbers and symbols related to basic mathematics to solve problems in various contexts of daily life, use the interpretation of analysis results in table form to predict and make decisions, and interpret the results of the analysis to predict and make decisions. Therefore, scaffolding is needed so that they can complete their task. It is recommended for teachers strengthen students' numeracy literacy skills for the material being studied and habituate students in working on varied questions so that skills and accuracy in analyzing questions can increase. This study only analyzes numeracy literacy skills in the number material of grade VIII (second grade) junior high school. Therefore, further research needs to be carried out including analyzing literacy skills based on MCA questions which include numbers, algebra, measurement and geometry, data and uncertainty, and designing numeracy literacy-based learning.

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