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Metacognitive Scaffolding in Solving Numerical Literacy Problems in Secondary School

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ABSTRACTS

This research is an exploratory with a qualitative approach that aims to describe the actual abilities, obstacles experienced by students, and the types of metacognitive scaffolding that need to be given to students in terms of improving numerical literacy problem-solving abilities. The validity of the data was obtained through in-depth interviews. The results of the study were obtained namely (1) Actual knowledge of subjects with moderate literacy (SS) ability improvement showed that they had understood the problem, but did not realize the need to include thick walls in calculating the volume of the pool. Meanwhile, subjects with increased low literacy (SR) skills did not understand the numerical literacy problems given and doubted the results of solving them. (2) The obstacles experienced by the SS were only because they did not realize the need to insert thick walls, so they experienced obstacles in each Step of Polya. While SR besides not understanding the problem of numerical literacy given, also not aware of what he writes. (3) The type of metacognitive scaffolding that needs to be given to SS and SR, shows that SR only needs a little help given, namely the type of monitoring and evaluating and the form of assistance is categorized subtly, namely only in the form of asking. As for the metacognitive SR scaffolding that needs to be given, which is mostly in the form of directing and several times given the type of monitoring and the form of assistance is also categorized as rough, which is mostly in the form of directing and several times in the form of orders.

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1. INTRODUCTION

The National Assessment is an assessment program for the quality of each school, madrasah, and equality program at the primary and secondary levels. The quality of education units is assessed based on basic student learning outcomes (literacy, numeracy, and character) as well as the quality of the teaching-learning process and the climate of education units that support learning (Novita et al., 2021). The information is obtained from three main instruments, namely Minimum Competency Assessment (AKM), Character Survey, and Learning Environment Survey.

Mena et al. (2016) revealed that the results of the analysis of the position of students in Indonesia from the results of PISA several years of implementation period showed the weak problem-solving ability of Indonesian students in solving contextual problems. This is possible because Indonesian students are not used to solving problems related to contextual numerical literacy. It is necessary for students to habituate to solving problems built from contextual problems, so that problem solving becomes a habit and cultivates in students.

Sari (2018) explained about the Regulation of the Minister of Education and Culture Number 23 of 2015 related to the literacy movement, namely one of the activities in the movement is a 15-minute activity of reading non-lesson books before learning time begins. This activity is carried out to foster students' interest in reading and improve reading skills so that knowledge can be mastered better. The policy of the Minister of Education, Culture, Research and Technology regarding independent campus learning follows up the literacy movement in the form of familiarizing students with literacy problems. These literacy problems are built from problems related to the situation around students called contextual.

The Ministry of Education, Culture, Research and Technology of the Republic of Indonesia has adopted a policy of revitalizing Higher Education and Teacher Training Institutions with collaborative programs between universities, especially LPTK and schools involving lecturers, teachers, and students. One of the appointed schools is SMP Islam Athirah 2 Makassar. At SMP Islam Athirah 2 Makassar, HOTS literacy learning has been carried out for 12 meetings with one Pre-test and two Post-tests. The material given during learning is congruence and congruence for six times and quadratic functions for six times. After the assessment, the results of the test post are analyzed to see the achievement and picture of the results of learning implementation by applying HOTS Literacy.

The implementation in this school is the first step to introduce literacy to students, therefore researchers want to find a pattern of literacy learning in schools, especially how teachers as facilitators in learning will facilitate students to learn and solve literacy problems, especially numerical literacy. More specifically, the form of assistance students need in learning and solving numerical literacy problems. One of the benefits that can be given to students is metacognitive scaffolding.

In metacognitive scaffolding, researchers give questions, orders, or directions to students in order to apply their metacognitive skills in the form of planning, monitoring, or evaluating each step and result in solving numerical literacy. This metacognitive scaffolding leads students to understand and realize each step in the solution. The problem-solving step in question refers to Polya's four steps, namely understanding the problem (Step 1), devising a plan (Step 2), carrying out the plan (Step 3), and looking back (Step 4).

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This study aims to find out: (1) the actual ability of students of SMP Islam Athirah 2 Makassar in solving numerical literacy problems, so that students are aware of every thought process and result; (2) obstacles experienced by students of SMP Islam Athirah 2 Makassar in solving numerical literacy problems, so that students are aware of every process and result of their thinking; and (3) what kind of metacognitive scaffolding needs to be given to students of SMP Islam Athirah 2 in solving numerical literacy problems, so that students are aware of each process and result of their thinking.

According to Santrock (2007), one of the experts in educational psychology said that, problem solving is looking for the right way to achieve a goal. This is in line with the opinion expressed by Bullok and Stallybras (Checkland, 1985) that problem solving is a form of activity that confronts the organism with a specific goal to be achieved that contains constraints or gaps in efforts to achieve that goal and is complemented by a set of alternative ways, but none of the ways are immediately clear and suitable.

With the habituation of students to solve problems and face global challenges, learning in schools with government policies to focus on solving reading, numerical and science literacy problems. These reading, numerical and science literacy problems can be applied to each field of study. Especially in this study will be examined in the numerical literacy section. Four steps of problem solving according to Polya (1973) that we often use in solving numeracy literacy problems are: (1) Understanding the problem, (2) Devising a plan, (3) Carrying out the plan, and (4) Looking back.

Flavell & Miller (Santrock, 2007) state that metacognition means 'cognition about cognition', or 'knowing about knowing'. Students who manage their cognitive activities allow them to handle tasks and solve problems well. It can also be said that metacognition is thinking about thinking. It also explains that thinking about thinking is one of the things that allows for better understanding than other students.

According to Anderson & Krathwohl (2001), metacognitive knowledge is knowledge about cognition in general as well as awareness and knowledge of one's own cognition. This includes knowledge of strategy (knowledge of some strategy and in which case it can be used); knowledge of cognitive tasks, including contextual knowledge and conditional knowledge (knowledge of the types of tasks or tests to be performed and knowledge of the cognitive demands (awareness) of the different tasks); and self-knowledge (awareness of one's own level of knowledge, including one's own abilities and weaknesses).

Good math problems for students to solve in learning to solve problems are math problems whose level of difficulty is in the nearest developmental area or ZPD (Zone of Proximal Development) students. ZPD is a level of development slightly above the level of development of students' knowledge at that time (Ratumanan, 2002). There are two levels of cognitive development of students proposed by Taylor, namely the level of actual development and the level of potential development. The actual level of development expressed as the level of cognitive development of the student carried out independently (without the help of someone who is more expert or better understand the problem in question) and the level of potential development expressed as the level of cognitive development of the student carried out with the help of someone who is more expert or understands the problem in question (without the help of a more expert person, then it is difficult to reach that level). So a student's ZPD is the area between the student's actual development and the student's potential development. In other words, the lower limit of the ZPD is the student's actual

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development level and the upper limit of the student's ZPD is the student's potential development level. To strive so that the assistance given to students is not only out of the obstacles experienced but can also be used when experiencing the same obstacles, assistance given by the term Metacognitive Scaffolding.

Metacognitive scaffolding can be interpreted as scaffolding given by adults or more experts in order to help students engage their metacognition through awareness of designing, monitoring, and evaluating their thinking processes and results (Dassa, 2010). By paying attention to the components of metacognitive knowledge, the metacognitive scaffolding giver will always trace the metacognitive involvement of students with the steps taken, strategies used, and cognitive results obtained. Tracing students' metacognition involvement can be done by interview or observation. Because scaffolding is gradual according to the minimum needs of students to overcome the obstacles they experience at that time.

Based on the opinions of Huitt (1997) and Meracah & Kramarski (2002) about questions/directions that can involve student metacognition associated with the three elements of metacognitive skills of students planning, monitoring, and evacuating, the following researchers define the types of metacognitive scaffolding along with some examples.

1. Metacognitive scaffolding that elicits students' understanding and awareness to do Planning is called metacognitive scaffolding type of planning, with examples such as the following.
    a. Do you know, what is known in this matter?
    b. Do you know, what is required in this matter?
    c. Do you know, what is asked in this matter?

2. Metacognitive scaffolding that raises students' awareness to perform monitoring is called metacognitive scaffolding of monitoring type, with examples such as the following.
    a. Take a look again to see if you have written all the known in the problem!
    b. Is it true that what you wrote is the thing being asked, are you sure that the solution is sought in that problem?
    c. What information is important for you to remember?
    d. Do the easiest part of the planning you know!

3. Metacognitive scaffolding that raises students' awareness to perform evaluations is called metacognitive scaffolding type of evaluating, with examples such as the following.
    a. Look back at your work, whether it is in accordance with the concepts or principles you know!
    b. Has your workaround answered the problem?
    c. Try to conclude in your own language, what you get!
    d. Have you answered all the questions in the problem?

2. METHOD

This type of research is eschlorative research with a qualitative approach. This study reveals the types of metacognitive scaffolding that need to be given to students in solving math problems, both students with low, medium, and high mathematical abilities. The

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researcher himself will be the main instrument that provides metacognitive scaffolding to students according to the needs of students at the time of solving mathematical problems. With regard to solving numerical literacy problems by students, we will explore the types of metacognitive scaffolding that students need when solving these mathematical problems. This research pays more attention to the process of giving scaffolding when solving mathematical problems than the results of solving them. The material chosen in this study is Bagun Ruang Sisi Datar.

From the results of literacy tests, both pre-test and post-test, normalized gein values are determined. Then group into three parts, namely the group of increasing high, medium, and low literacy abilities. Data were obtained from 36 medium category students and 4 low category students from 40 students studied.

Table 1. Results of Student Literacy Ability Gain Value

Gain-Value Range	Category	Frequency (students)
G ≥ 0.3	High	0
0.3 ≥ G ≥ 0.7	Medium	36
G ≥ 0.3	Low	4
Total		40

The data collection stage is first given numerical literacy problems done independently, then task-based interviews are conducted. To obtain data related to research questions, researchers conduct task-based interviews. In the interview, the researcher traced his actual knowledge with questions included with metacognitive scaffolding. The function of metacognitive scaffolding is to provide assistance to students as needed until students realize their knowledge and every process / step taken, so that it will reveal the abilities possessed without the help of others called actual abilities, obstacles experienced, and what type of scaffolding needs to be given when solving numerical literacy problems.

3. RESULTS AND DISCUSSION

Results

Before presenting the problem, the researcher first provides coding from the results of solving students' numerical literacy problems as follows.

In this study, there were two subjects, namely SS (Subjects with Moderate literacy ability improvement) and SR (Subjects with Low literacy ability improvement) with two questions, namely question 1 and question 2. Three types of metacognitive scaffolding can be given to respondents, namely: (1) planning, (2) monitoring, and (3) evaluating. While the four steps Polya refers to in problem solving, namely: (1) understanding the problem, (2) devising a plan, (3) carrying out the plan, and (4) looking back.

Description of Metacognitive Scaffolding Data in Numerical Literacy Problem Solving According to Four Polya Steps

First Numerical Literacy Problem given:

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It is believed that swimming began as an organized activity as early as 2500 years BC in ancient Egypt. This activity quickly spread to other parts of the world such as ancient Greece, Rome, and Assyria. In Rome and Greece, swimming began as a form of education, all men were expected to know how to swim and they were taught at a very young age.

Figure 1. Swimming Pool and Its Size

Mr. Amir completes the yard of his villa with a block-shaped swimming pool the size as shown above. The swimming pool is intended for children and adults, so the pool is divided into two parts, namely the 15-meter long one is made with a depth of 2 meters and the remaining 5 meters is made with a depth of 1 meter.

Question:

1. The volume of the pool can be calculated by:
   a. Explain how you can calculate the volume of the pool!
   b. Calculate the volume of the pool using your means in section a)!
2. If the swimming pool is empty and wants to be filled with water to the brim and every 1 m^3 takes 5 minutes, then how long will it take to fill the pool?

a. Subjects with Improved Moderate Literacy Ability (SS)

The following describes SS's answers and types of metacognitive scaffolding accompanied by interviews given to SS in solving numerical literacy problems and sorted according to Polya's four steps as follows:

1) Understanding the problem

The SS wrote down the solution as follows:

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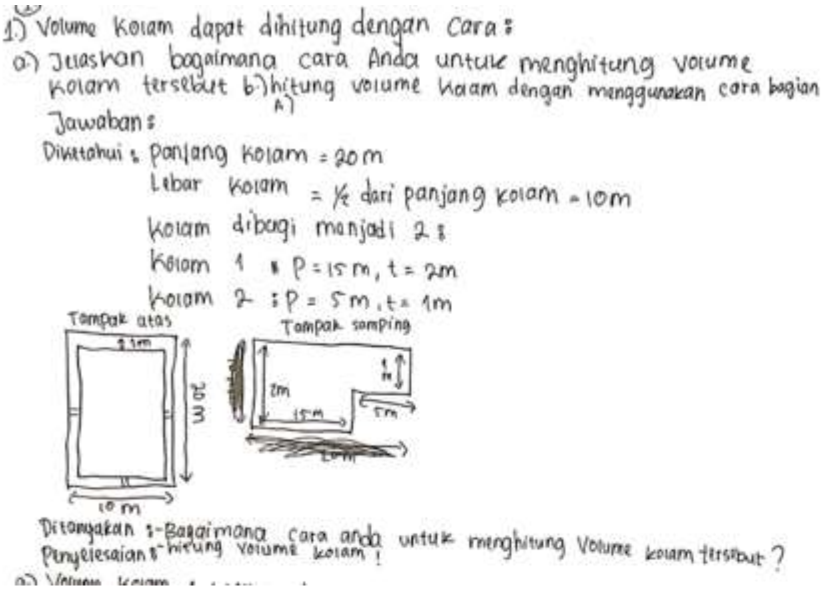

Figure 2. Understanding the Problem of SS

a) Actual knowledge

From the results of SS solving in understanding the problem, it is written:

- The general thing is the length of the pool, the width of the pool, and the height of the pool and shows that there are two pools of their respective sizes.
- There is no written part that is not commonly known when doing the problem, namely the thickness of the pool wall.
- The drawings made look rather complete what is known, but in writing not all.
- SS can write down what is asked i.e. how do you calculate the volume of the pool? and calculate the volume of the pool!
- On question number 2 written the known and the asked.

b) Obstacles experienced by the SS

The SS could not translate in written form (not pictures) about the thickness of the walls.

c) Type of metacognitive scaffolding given

From the results of SS audio recordings during interviews accompanied by metacognitive scaffolding, the types of metacognitive scaffolding most often given consecutively are as follows: Most given metacognitive scaffolding types of monitoring and evaluating, while less planned types are given. Metacognitive scaffolding is given mostly in the most subtle form of asking, as it quickly realizes its mistakes.

2) Devising a plan

The SS wrote the completion plan as follows:

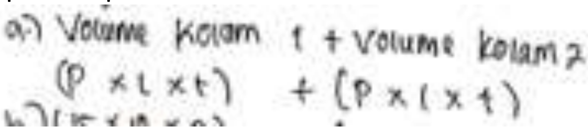

Figure 3. Devising a Plan of SS

a) Actual knowledge

The SS formulated a settlement plan by writing the formula for volume p x l x t.

b) Obstacles experienced by the SS

- The SS formulated a settlement plan that did not include the thickness of the wall, so the formula used for the volume of the pool to be filled with water was incorrect.
- Planning written only based on what is written and what is known.

c) Type of metacognitive scaffolding given
From the results of SS audio recordings during interviews accompanied by metacognitive scaffolding, the types of metacognitive scaffolding most often given to planning successive completions are as follows: Most given metacognitive scaffolding type planning and monitoring type, while less evaluating type given. Metacognitive scaffolding is given mostly in the most subtle form of asking, as it quickly realizes its mistakes.

3) Carrying out the plan
The SS wrote down the settlement as follows:

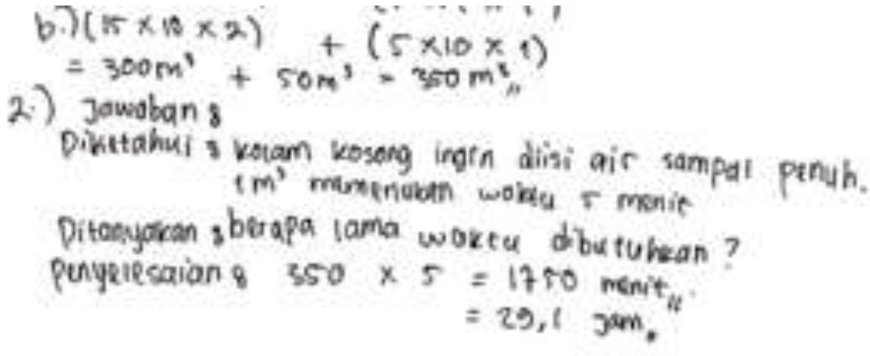

Figure 4. Carriying Out the Plan of SS

a) Actual knowledge
SS solved the numerical literacy problem by using the formula volume p x l x t = 15 x 10 x 2 + 5 x 10 x 1.
b) Obstacles experienced by the SS
The SS solved the problem of numerical literacy without realizing that the planning had been made incorrect, so the formula used still did not consider the thickness of the pool.
c) Type of metacognitive scaffolding given
From the results of SS audio recordings during interviews accompanied by metacognitive scaffolding, the types of metacognitive scaffolding most often given at the time of solving problems successively are as follows: Most given metacognitive scaffolding type planning and monitoring type, while less evaluating type given. Metacognitive scaffolding is given mostly in the most subtle form of asking, as it quickly realizes its mistakes.

4) Looking back
From the audio recording of SS during the interview accompanied by metacognitive scaffolding, SS was not given metacognitive scaffolding, because he immediately realized his wildness during the review.

b. Subjects with Improved Low Literacy Ability (SR)

The following describes SR's answers and types of metacognitive scaffolding accompanied by interviews given to SR in solving numerical literacy problems and sorted according to Polya's four steps as follows:

1) Understanding the problem
The SR wrote down the solution as follows:

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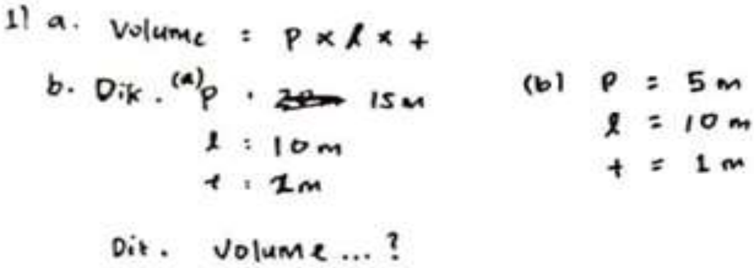

Figure 5. Understanding the Problem of SR

a) Actual knowledge
From the results of SR solving in understanding the problem, it is written:
- The general thing is the length of the pool, the width of the pool, and the height of the pool and shows that there are two pools of their respective sizes.
- Not writing pictures.
- SR can write down what is asked i.e. volume?

b) Obstacles experienced by the SR
- SR does not write about the thickness of the wall.
- SR does not write down what volume is asked.
- There is nothing written or in the picture that the SR knows that there is a thick wall to be aware of.

c) Type of metacognitive scaffolding given
From the results of SR audio recordings during interviews accompanied by metacognitive scaffolding in understanding the problem. The most commonly administered types of metacognitive scaffolding are consecutively as follows: Most given metacognitive scaffolding types plan and monitor. This is done on a repetitive basis, while less planning types are given. Metacognitive scaffolding is given more often in the form of directives, then commissions. Rarely given in the form of asking.

2) Devising a plan

The SR wrote the completion plan as follows:

Figure 6. Devising a Plan of SR

a) Actual knowledge
SR formulates a settlement plan by writing the formula for volume p x l x t.

b) Obstacles experienced by the SR
- SR formulates a settlement plan that does not include the thickness of the wall, so the formula used for the volume of the pool to be filled with water is incorrect.
- Planning written only on the basis of what is written and what is known.
- Does not involve thick walls in the planning.
- Did not do question number 2. The SS formulated a settlement plan that did not include the thickness of the wall, so the formula used for the volume of the pool to be filled with water was incorrect.

c) Type of metacognitive scaffolding given
From the results of SR audio recordings during interviews accompanied by metacognitive scaffolding, the types of metacognitive scaffolding most often given to saan plan completion successively are as follows: Most given metacognitive scaffolding type planning and monitoring type, while less evaluating type given. Metacognitive

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scaffolding is given more often in the form of directives, then commissions. It is rarely given in the form of asking.

3) Carrying out the plan

The SR wrote down the settlement as follows:

Figure 4. Carriying Out the Plan of SR

a) Actual knowledge

SR solves numerical literacy problems by using the formula volume p x l x t = 15 x 10 x 2 + 5 x 10 x 1.

b) Obstacles experienced by the SR

- R solves numerical literacy problems without realizing that the planning has been made wrong, so the formula used still does not take into account the thickness of the pool.
- SR did not solve question number 2

c) Type of metacognitive scaffolding given

From the results of SR audio recordings during interviews accompanied by metacognitive scaffolding, the types of metacognitive scaffolding most often given at the time of solving problems successively are as follows: Most given metacognitive scaffolding type planning and monitoring type, while less evaluating type given. Metacognitive scaffolding is given more often in the form of directives, then orders and rarely given in the form of asking.

4) Looking back

From the results of SR audio recordings during interviews accompanied by metacognitive scaffolding. SR is not given metacognitive scaffolding. He said he did not conduct a review and he realized his wildness after being given metacognitive scaffolding.

Discussion

Based on the description of the research results, then the following analysis and discussion are carried out.

a. Actual Knowledge

1) Subjects with Improve Moderate Literacy Ability (SS)

SS subjects understood the problem well, this was demonstrated by writing down the picture completely. However, the SS did not realize the function of the thickness of the wall indicated by not writing the known, so in writing it was incomplete that is, it was not written in thickness. When interviewed, SS said he viewed the information but did not realize that it affected volume calculations. This causes constantly wrong in the 2nd,

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3rd, and 4th Polya Steps. It is proven that after being given metacognitive scaffolding, SS smoothly solved the literacy problems given, both for number 1 and number 2.

2) Subjects with Improved Low Literacy Ability (SR)
SR subjects lacked understanding of the problem, only being able to write down the length, width, and height of both known pools. There is no information on the known thick written wall. This also causes SR to be wrong in each of the 2nd, 3rd, and 4th Polya Steps. Also, SR did not realize the need to put thick walls to know. Because question 1 SR doubted the results of his work, so question number 2 was not done.

The analysis of SS and SR understanding above shows that SS understood the problem, but did not realize the need to include thick walls. Another case with SR is indeed not understanding the problem, so it doubts the results of its resolution.

b. Obstacles experienced

1) Subjects with Improve Moderate Literacy Ability (SS)
The SS subjects did not realize that the thickness of the walls affected the determination of the volume of the Pool, and this led to errors in the 2nd, 3rd, and 4th Polya Steps. It is proven that after being given metacognitive scaffolding, SS smoothly solved the literacy problems given, both for number 1 and number 2.
2) Subjects with Improved Low Literacy Ability (SR)
SR subjects do not understand well the given problem and also do not realize that wall thickness can affect the determination of pool volume. SR was unable to complete every Polya Step.

From the results of the analysis of obstacles experienced by SS and SR above, it shows that SS obstacles are only because they do not realize the need to enter thick walls. While SR besides not understanding, also not realizing it.

c. Type of metacognitive scaffolding given

1) Subjects with Improve Moderate Literacy Ability (SS)
Because SS has an understanding of the numerical literacy problem given, so it can always write down the next step. This leads to a type of mecocognitin scaffolding that is often given i.e. a new type of monitor evaluates whereas planning is almost never. Judging from the subtlety of the assistance provided, giving scaffolding to SR is only in the form of asking, and has been able to get out of obstacles and can already realize it.
2) Subjects with Improved Low Literacy Ability (SR)
Because SR has a good understanding of the numerical literacy problem given, so it is always difficult to start the next step. This leads to the type of mecognitone scaffolding that is often given, namely the new type of planning monitoring, and the least that is evaluating. Judging from the subtlety of the assistance provided, the provision of scaffolding to SR is mostly in the form of directing, even several times in the form of orders.

From the results of the analysis of the type of metacognitive scaffolding given to SS and SR above, it shows that SS has little help given and the form of assistance is also finely categorized. Another case with SR is that a lot of assistance is provided and the form of assistance is categorized more roughly, because it must be directed.

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4. CONCLUSION

The actual knowledge of subjects with moderate literacy improvement (SS) and subjects with low literacy improvement (SR) showed that SS understood the problem, but did not realize the need to include thick walls in the volume of the pool. Meanwhile, SR does not understand the numerical literacy problem given and doubts the results of its completion. Only write down some of what is known and do not write down the thickness of the wall that is part of the school that must be known. This shows that there is a tendency for students to still be less accustomed to doing literacy, so that the information on the numerical literacy problem provided, cannot be understood properly.

The obstacles experienced by the SS and SR show that the SS was only unaware of the need to insert thick walls, so they experienced obstacles in each Step of Polya. While SR besides not understanding the problem of numerical literacy given, also not aware of what he writes.

The type of metacognitive scaffolding that needs to be given to SS and SR, shows that SR only needs a little help given, namely the type of monitoring and evaluating and the form of assistance is also finely categorized, namely only in the form of asking. As for SR Metacognitive scaffolding that needs to be given, which is mostly in the form of directing and several times given the type of monitoring and the form of assistance is also categorized roughly, which is mostly in the form of directing and several times in the form of orders.

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