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ROLE OF SCAFFOLDING FOR REFLECTIVE THINKING ON THE MATHEMATICAL PROBLEM SOLVING

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Abstrak

Mahasiswa calon guru SD dituntut untuk memiliki kemampuan pemecahan masalah dan pengetahuan yang tepat dalam memilih strategi pemecahan masalah yang sesuai. Salah satu upaya yang dapat digunakan untuk mendorong keterampilan pemecahan masalah adalah dengan mengembangkan kemampuan berpikir reflektif. Berpikir reflektif merupakan strategi untuk menggali kemampuan pemecahan masalah matematis dengan cara mempertanyakan jawaban atau mempertanyakan masalah yang dihadapi, sehingga pemikiran baru dapat terbentuk dan digunakan untuk menentukan strategi pemecahan masalah yang tepat. Oleh karena itu, penelitian ini bertujuan untuk menjelaskan peran *scaffolding* dalam proses berpikir reflektif yang dilakukan oleh calon guru SD dalam menyelesaikan masalah matematika. Penelitian ini menggunakan desain penelitian kualitatif dengan pengumpulan data melalui proses tes dan wawancara sebagai tahap triangulasi. Partisipan dalam penelitian ini terdiri dari dua orang calon guru SD yang melakukan proses berpikir reflektif dan diketahui melalui *think aloud* dalam melaksanakan tes. Hasil penelitian menunjukkan bahwa *scaffolding* diperlukan untuk melengkapi proses berpikir reflektif dalam pemecahan masalah. Posisi *scaffolding* muncul dua kali dalam tahap berpikir reflektif: (1) setelah tahap menanya dan mengevaluasi, *scaffolding* diperlukan sebagai jembatan menuju tahap menalar; (2) setelah tahap menanya, *scaffolding* diperlukan untuk menjembatani antara tahap evaluasi dan penalaran. Pada proses berpikir reflektif, *scaffolding* menghasilkan pengetahuan baru untuk menemukan strategi pemecahan masalah yang tepat.

Kata kunci: berpikir reflektif; calon guru SD; pemecahan masalah

Abstract

Prospective teachers, particularly in primary school, are expected to be able to acquire and develop knowledge and experience in selecting appropriate solutions in solving mathematical problems. One of the efforts that can be used to encourage problem-solving skills is to develop reflective thinking. Reflective thinking can be a strategy to explore mathematical problem-solving abilities by questioning the answers or questioning the problems encountered so that new thoughts can be used to determine appropriate problem-solving strategies. Therefore, this study aims to explain the role of scaffolding for reflective thinking process carried out by prospective teachers in solving mathematical problems. This study used a qualitative research design with data collection through test and interview process as a triangulation stage. Participants in this study were 2 prospective teachers who carried out a reflective thinking process and were known through think aloud in implementing the test. The results showed that scaffolding was needed to complete the reflective thinking process in problem-solving. Two scaffolding positions appeared in the reflective thinking stage: (1) after the questioning and evaluating stages, scaffolding is needed as a bridge to the reasoning stage; (2) After the questioning stage, scaffolding is needed to bridge the evaluating and reasoning stages. In the reflective thinking process, scaffolding generates new knowledge to find the right problem-solving strategy.

***Keywords**: problem-solving, prospective teachers, thinking reflective*

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INTRODUCTION

The development of teachers' abilities in learning practices can begin with learning strategies that lead to confusing situations so that teachers begin to rearrange this view of learning practices which is called the process of reflection in action (Carter, 1990). Learning, as stated by Dewey (1933) fundamentally consists of reflection on experiences.

Reflective thinking itself is one form of high order thinking skills in flexibly accessing or connecting existing knowledge or experiences in the past to solve new problems related to those old knowledge or experiences (Muzaimah & Noer, 2019). This reflecting process implies the process of analysing and making judgement about what needs to be known and what has been previously known (Dewey, 1933). In other words, reflective thinking aims to bridge the gap between self-discovery and development by expanding the existing knowledge (Pretorius et al., 2017).

Interestingly, views on indicators of reflective thinking skills are varied. Noer (in Muzaimah & Noer, 2019) proposed 3 levels that indicate reflective learning among learners: reacting, comparing, contemplating. The prior level describes reflective thinking for action, while the latter respectively describe reflective thinking for evaluation and reflective thinking for critical inquiry. In addition, Kizilkaya & Askar (2009) and Tuncer & Ozeren (2012) theorized that reflective thinking consists of the questioning, evaluating, and reasoning stages. Questioning can be seen when someone questions their answers or experiences confusion. The evaluating process generates new thoughts from this confusion and can find new knowledge to determine logical strategies in solving mathematical problems (reasoning).

Process or reflective thinking becomes an effort or tool that can be used to encourage the thinking process in problem-solving because it provides an opportunity to look back on problems, knowledge, or previous experiences and think of the best strategy to solve problems that confuse them (Choy, 2012; Dewey, 1933; Prayitno et al., 2016; Sanders & Moulenbelt, 2011).

Problem-solving can be used as a starting point in the practice of learning mathematics and one's mathematical thinking process (Nanna & Pratiwi, 2020). In line with what Avcu & Avcu (2010) stated, it is crucial to know and investigate how problem-solving strategies of prospective teachers so that their problem-solving skills develop correctly. It is because prospective teachers, particurarly at primary school teacher education department in Universitas Borneo Tarakan, as future primary school teachers, need to be accustomed to doing the reflection process in order to improve their competence in both the process and practice of solving problems.

In the application of problem-solving, a strategy is needed to be used during problem-solving. Polya (2004) developed a problem-solving model known as "understanding the problem", "devising a problem", "carrying out the plan", and "checking solution." Subsequently, Nunokawa (2005) states that problem solving can be done by following the steps (a) mathematical knowledge that is owned, (b) is applied to understand the problem situation, (c) obtains new information from the problems encountered, and (d) tries to take advantage of further information by reflecting so that they find new

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methods or ideas to solve their mathematical knowledge problems.

Jagals & Walt (2016), in his research, revealed that when carrying out the reflection process, students not only remember the conditions and the content of the problem but consciously search back the knowledge or experience to understand the situation well. This condition can support students' activities in constructing and developing metacognitive, creative, and independent understanding related to problem-solving (Jagals & Van Der Walt, 2016; Johns, 2017).

As a matter of fact, several studies have reported that reflective processes could be observed when solving mathematical problems. For instance, Kizilkaya & Askar (2009) developed a scale to measure reflective thinking in solving mathematical problems; Hidajat (2019) linked reflective thinking to problem-solving geometric matter with creative thinking. Furthermore, Demirel et al. (2015), used a reflective thinking scale that have been developed by a reflective process based on gender and attitudes. Meanwhile, the reflective thinking scale (questioning, evaluating, reasoning) developed by Kizilkaya & Askar (2009) is applied as long as students carry out the process of solving mathematical problems related to geometry. Therefore, this study aims to describe the reflective thinking process carried out by prospective teachers in solving math problems.

METHODS

In solving mathematical issues using a qualitative exploratory approach, this study reveals a reflective thinking process. The reflective thinking process in question consists of the questioning, evaluating, and reasoning stages. The research instrument used was a mathematical problem-solving sheet composed of two geometry material problems and an interview guide. The following issues are given in this research:

1. Mr. Rama will put wallpaper in his photo studio with a length of 6 m, a width of 3 m, and a height of 3 m. One roll of wallpaper that he will buy is 10 x 45 cm at a price of Rp.45,000.00. How much money would Mr. Rama have to spend to purchase wallpaper if only three studio walls were installed?
2. Mother has a jar with a radius of 14 cm and a height of 30 cm. The jar will store the palm sugar with a radius of 7 cm and a height of 6 cm. What is the maximum whole palm sugar that a mother can neatly arrange into a jar? The Figure 1 is the mother's jar and palm sugar:

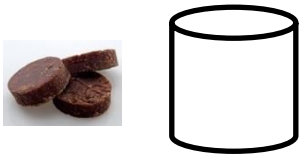

Figure 1. Mother’s jar and palm sugar

Participants in this study are 37 prospective primary teachers who were given the mathematical problems related to geometry. Based on the think-aloud process carried out by 37 prospective teachers, it was found that two prospective teachers took the reflective thinking stage in solving math problems.

Research procedure begins with data collection from prospective teachers worksheets, recordings of think-aloud prospective teachers when solving problems, and interview results were obtained from this study. Think aloud is used to check the reflective thinking process carried out by the

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prospective teachers when solving math problems, which is then confirmed through in-depth interviews as a triangulation process. The researcher then used 2 out of 37 prospective teachers who were invited into an in-depth interview process in order to figure out their reflective thinking process.

In this study, data analysis used data reduction and data presentation to obtain the research findings from researchers (Huberman & Miles, 2012).

RESULT AND DISCUSSION

Problem-solving carried out by prospective teachers includes applying their mathematical knowledge to understand the problem situation, thus obtaining new information from the problems encountered, and taking advantage of this further information by carrying out a reflective process (questioning, evaluating, and reasoning). After that, participant 1 is referred to as P1 and participant 2 is referred to as P2, the research results obtained with the same scaffolding position are presented on the basis of the think-aloud in solving mathematical problems performed by the two participants.

Scaffolding in the First Problem Reflective Process

Figure 2 illustrates P1 and P2 in solving the first problem. Based on Figure 2, information is obtained that P1 and P2 do not do reflective thinking in the early stage because both participants know the problem. This condition is known through the following think aloud.

> *Hmm, this is how you find the wall area using the area formula for a rectangle.* (P1)

> *This is looking for the wall area because the wall is a square shape, souse the formula p x l, then multiply by 3.* (P2)

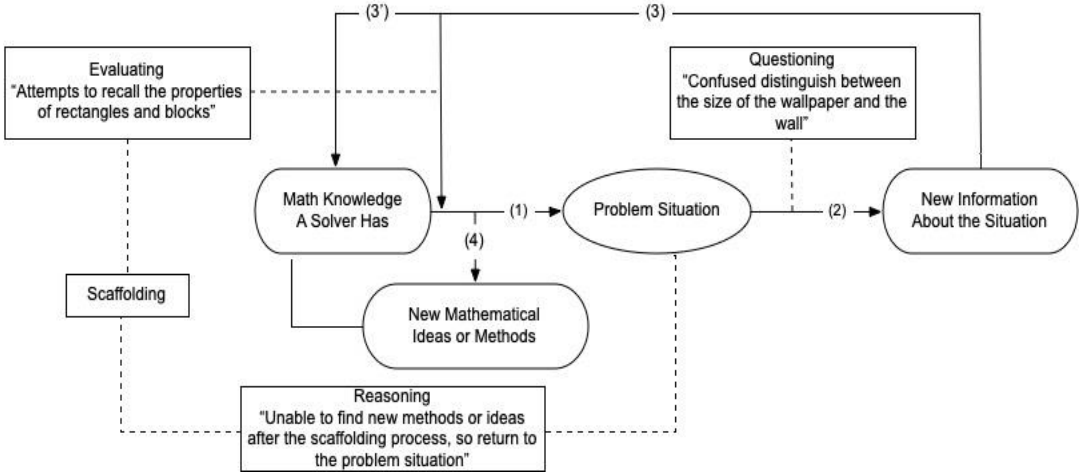

Figure 2. Process of reflective thinking in problem-solving by P1 and P2

In the second stage, when P1 and P2 re-understand the problem, they do reflective thinking, namely questioning. They experience confusion between wall size and wallpaper. When trying to use the new information, both participants attempted to recall the rectangle's properties and the blocks. This section shows that P1 and P2 are doing reflective thinking, namely evaluating. However, P1 and P2 experienced difficulties understanding the properties of rectangles and blocks used in the given problem. They still

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think that walls and wallpaper have different shapes; this is known through the following sample, think-aloud following quote on participant 1.

> *How about this, the wall is building space while the wallpaper is flat. (P1)*

The think-aloud following quote above is strengthened through the interview process below:

> *Are you sure about the problem-solving strategy? (R)*
> *Hmm, not sure, ma'am. The wallpaper is only long and wide, but the wall is attached to the floor and ceiling, so there is a height. (P1)*

In the third stage, the two participants are given scaffolding to overcome the obstacles they experience when they have received new information from the problem situation at hand. Tawfik et al. (2018), in his research suggests that scaffolding is an essential facet with problem-solving capability. Furthermore, Alrawili et al. (2020) stated that scaffolding is essential to help students realize their knowledge and then help their thinking skills process. In Table 1, the form of scaffolding given can be seen in the interview.

Table 1. Forms of scaffolding in the first problem

Scaffolding	Participant Response
Is the method of determining the area of the wall the same as the area of the wallpaper?	Different ma'am, the wall has a height while the wallpaper does not
Can you describe the wall, you mean?	*(Draw a rectangle)* This is the wall *(points to the rectangular drawing)*, then the height including its wall is between the floor and the ceiling.
So still, the area of the wall uses the height?	Yes, ma'am. Constantly

Giving scaffolding to the two participants failed in overcoming the obstacles they experienced. Therefore, participants erroneous in finding new strategies to solve problems when doing reflective thinking, namely reasoning. The inability to determine an excellent problem-solving approach can occur because students have made mistakes when making mathematical classifications resulting in logical and strategic errors (Nanna et al., 2020). In line with Demirel et al. (2015), this condition requires more effort to develop the reflective thinking abilities of students to successfully solve mathematical problems. According to Tuncer & Ozeren (2012), it is possible to develop the reflective thinking skills of students through quality teacher training. Teachers should be encouraged to activate strategies in their class now and in the future that present the mental activities of students, such as reflective and critical thinking.

The two participants could not solve the first problem because they were confused between walls and wallpapers. Even in the reflective thought process, they assisted with scaffolding, P1 and P2 still couldn't solve it. Hidajat et al. (2019), stated that students' confusion while solving problems shows students'

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unconventional imaginations on non-regular issues, misunderstandings due to experience obstacles, and failure to find new ideas and strategies in the process.

Scaffolding in the Second Problem Reflective Process

Figure 3 illustrates P1 and P2 in solving the first problem. Based on Figure 3, information is obtained that P1 and P2 do not do reflective thinking when applying mathematical knowledge because they already have knowledge related to spatial shapes. Furthermore, in the second stage, when understanding the problem, the two participants experienced confusion in choosing between the surface area and volume formulas to determine the amount of palm sugar that can be filled into the jar. This condition shows that the participants are doing reflective thinking, namely questioning. Further, the following quote of think-aloud can be seen below:

> *I think, if i use the concept of volume, the amount of sugar would be too much, and it some how does not make sense. (P1)*
>
> *Hmm should use volume, but the palm sugar in the jar is too much. It seems enough if you use the surface area of the tube. (P2)*

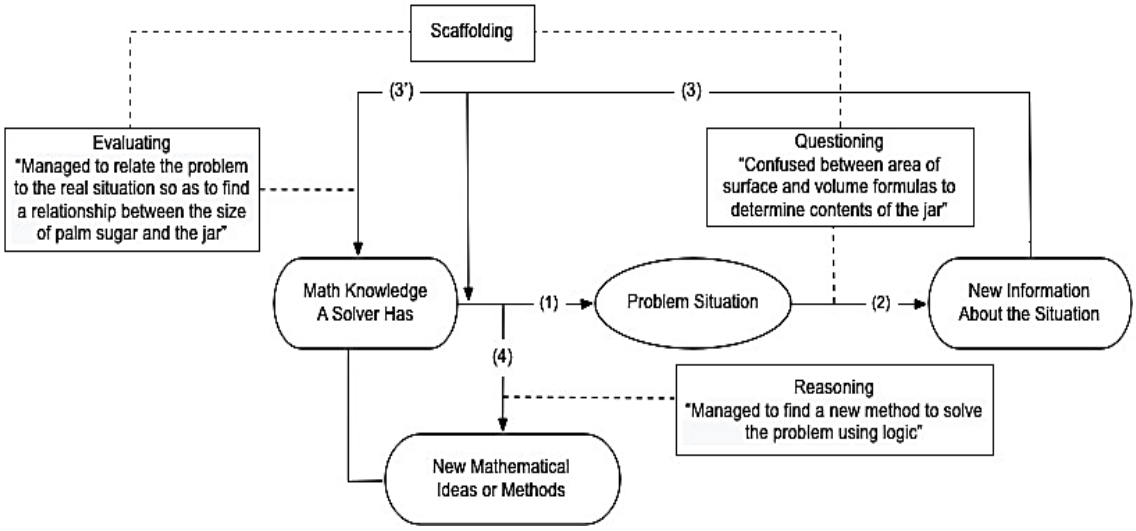

Figure 3. Process of reflective thinking in problem-solving by P1 and P2

According to (Riastuti et al., 2017), students need to know their mistakes when solving geometry problems to do reflective thinking to correct their errors. Mistakes in solving problems are sometimes because students are not able to imagine geometric shapes very well. Both participants experienced the same obstacles when determining the strategy they would use so that the researcher gave scaffolding. In the interview excerpt in Table 2, we can see the form of scaffolding provided.

Table 2. Forms of scaffolding in the second problem

Scaffolding	Participant Response
In your opinion, is the surface area and tube volume the same?	Confused ma'am

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Scaffolding	Participant Response
Can visualize?	*(Take a glass provided surface area and volume).* The volume is inside, and the surface area is outside.
So what formula are you using?	Volume ma'am, but I don't use the formula. Just pay attention to the size of the radius and height of the palm sugar and the jar.
Are you sure?	Yes, ten palm sugar because I am more confident by using logic.

The participants' responses in Table 2 indicate the occurrence of a reflective thinking process, namely evaluating and reasoning after being given scaffolding. Evaluating is seen at the stage of utilizing new information obtained from the scaffolding process. The latest report is that the participants managed to distinguish between the tube's surface area and volume by using concrete objects. Utilization of considering new information allows participants to find new methods or strategies to solve problems. This further reports that the participants are doing reflective thinking, namely reasoning. According to Birjandi & Jazebi (2014) opinion, scaffolding provides opportunities for students to support a learning environment to encourage students to try alternative problem solving based on their experiences, knowledge, and thoughts.

CONCLUSION AND SUGGESTION

This study has confirmed that reflective thinking can be a strategy to explore mathematical problem-solving abilities by questioning the answers or questioning the problems encountered, so that new thoughts can be used to determine appropriate problem-solving strategies. The results showed that scaffolding was needed to complete the reflective thinking process in problem-solving. Giving scaffolding can help to re-understand the problem situation, recall the information that students have and find new knowledge so that students can solve mathematics problems well. Two scaffolding positions appear in the reflective thinking stage: (1) scaffolding is necessary as a bridge to the reasoning stage after the questioning and evaluating phases; (2) scaffolding is required after the questioning process to bridge the gap between evaluating and reasoning processes. In the reflective thinking process, scaffolding generates new knowledge to find the right problem-solving strategy. Teachers can use scaffolding strategies to assist students in the reflective thinking process when facing obstacles in solving mathematics problems.

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