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The Metaphorical Thinking of Junior High School Student in Solving Algebraic Problem

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Abstract. Metaphorical thinking is one way of thinking in building abstract concepts through concrete things. Abstract ideas in metaphorical thinking are metaphorized into real-world things. This study aims to describe the metaphorical thinking profile of junior high school students in solving algebraic problems. The problem-solving steps used are the Polya model and the stages of metaphorical thinking using the *CREATE* criteria by Siler. This research is qualitative research using a descriptive approach. This study involved one of the seventh-grade students in a private junior high school in Surabaya who got the highest score on the preliminary test, namely the mathematical ability test. The data collecting technique employed in this study was problem-solving assignments and semi-structured interviews. Time triangulation was performed to assess the data from this study's credibility. Based on the analysis results, the subject has not been optimal in revealing the *CREATE* criteria for metaphorical thinking. The research subject has not been able to find a suitable metaphor for the algebra problem, so the subject did not reveal the *Connect* and *Relate* criteria. However, the subject revealed *Explore* criteria by designing mathematical models on the algebraic problem. The subject was able to determine the mathematical processes needed to solve the problem for the *Analyze* criteria, and the subject was also able to explain the procedures she took before. The subject discovered the *Transform* criteria by inferring and interpreting data based on earlier work. Last, the subject revealed the Experience criteria by explaining a new challenge using the model that had been created previously.

Keywords: Algebraic Problem; Metaphorical Thinking; Problem Solving

Abstrak. Berpikir metaforis merupakan salah satu cara berpikir dalam membangun konsep-konsep abstrak melalui hal-hal yang konkrit. Ide-ide abstrak dalam pemikiran metaforis dimetaforakan menjadi hal-hal dunia nyata. Penelitian ini bertujuan untuk mendeskripsikan profil berpikir metaforis siswa SMP dalam menyelesaikan soal aljabar. Langkah pemecahan masalah yang digunakan adalah model Polya dan tahapan berpikir metaforis menggunakan kriteria *CREATE* oleh Siler. Penelitian ini melibatkan salah satu siswa kelas VII SMP swasta di Surabaya yang memperoleh nilai tertinggi pada tes pendahuluan yaitu tes kemampuan matematis. Teknik pengumpulan data yang digunakan dalam penelitian ini adalah tugas pemecahan masalah dan wawancara semi terstruktur. Triangulasi waktu dilakukan untuk menilai kredibilitas data dari penelitian ini. Berdasarkan hasil analisis, subjek belum optimal dalam mengungkapkan kriteria *CREATE* dalam berpikir metaforis. Subjek penelitian belum dapat menemukan metafora yang cocok untuk masalah aljabar sehingga subjek penelitian tidak mengungkapkan kriteria *Connect* and *Relate*. Namun, subjek mengungkapkan kriteria *Explore* dengan merancang model matematika pada masalah aljabar. Subjek mampu menentukan proses matematis yang diperlukan untuk menyelesaikan masalah untuk kriteria *Analyze*, dan juga mampu menjelaskan prosedur yang ia tentukan sebelumnya. Subjek mengungkap kriteria *Transform* dengan menyimpulkan dan menafsirkan informasi berdasarkan apa yang telah dilakukan sebelumnya. Terakhir, subjek mengungkapkan kriteria *Experience* dengan menjelaskan masalah baru menggunakan model yang telah dibuat sebelumnya.

Kata kunci: Berpikir Metaforis; Masalah Aljabar; Pemecahan Masalah

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INTRODUCTION

Humans have various activities supporting their needs, one of which is thinking. Humans can obtain and process information, remember, and use things by thinking. In the thinking process, people can develop brilliant ideas and then also be able to learn something new about other human ways of thinking. A good thinker must be introduced to problem situations to develop his ideas, as well as in the learning process. In learning mathematics, thinking is critical because mathematics is a universal science that underlies the development of modern technology, has a vital role in various disciplines, and advances human thinking. Mathematics courses should be taught to all learners from primary schools, according to The Ministry of Education and Culture Circular No. 59/2014, in order to equip learners with the ability to think rational, analytical, systematic, critical, innovative, creative, as well as the ability to cooperate.

One method is teaching mathematics as a thinking activity (Devlin, 2012). This activity provides students with "problem-solving tools" that will enable them to adapt to changing circumstances (Treffinger et al., 2008). In the problem-solving process, thinking is an activity that cannot be eliminated. In the twenty-first century, the process of problem-solving in which significant scenarios occur and thinking abilities are applied is seen as fundamental (Bellanca, 2015; Zanartu et al., 2015). Thinking is an intense process of solving problems by relating one thing to another to obtain a solution. In other words, problem-solving is the result of thinking. Problem-solving is an essential part of mathematics and a process for developing students' mathematical thinking skills (Lubis et al., 2020).

One of the essential functions of mathematics teaching and learning is to establish the ability to solve various abstract mathematical problems (Singh et al., 2018). Students who acquire problem-solving skills and trained individuals who can cope with the problems encountered in real life are the priority goals and main goals of education today (Memnun et al., 2012). It should be utilized to assist students in learning new skills, solve issues, develop various techniques, and track and reflect on their progress. Students can establish persistence habits and build confidence through problem-solving skills, which will help them succeed in school, life, and the workplace (Demirel et al., 2015). Researchers used the Polya problem-solving model (Polya, 1973). Polya proposed the four-stage problem-solving process. Firstly, understanding the problem. This stage entails understanding the problem by describing it in our own words, identifying the information provided, and determining what is being asked. Secondly, devising a plan. It means exploring techniques to answer the problem, such as creating a picture or using variables to form an equation. Thirdly, carrying out the plan. This step entails putting the previous stage's strategy into action. If the strategy fails, more options will be considered until the problem is resolved. This step frequently comprises a trial-and-error procedure. Lastly, looking back at the process. At this stage, students reexamine the problem to confirm that all portions of the questions have been answered and that all conditions have been met adequately.

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Recognizing the undergone process and being able to apply it to other future challenges is also part of reflecting on the problem (Simpol et al., 2018).

Humans generally build abstract concepts through concrete things, using various ideas and varied ways based on their sensory-motor system. One of the thinking concepts that connect phenomena or real life and mathematics is metaphorical thinking. Metaphorical thinking is one way of thinking students build abstract concepts through concrete things. In metaphorical thinking, abstract concepts are metaphorized into natural objects in everyday life. When identifying concepts, students must be able to relate their mathematical ideas. Through metaphorical thinking, students are indirectly allowed to participate in learning by stimulating students ideas or thoughts by connecting abstract mathematical concepts with natural phenomena around them (Walfurqan, 2015). The problem-solving process is closely related to metaphorical thinking skills. Metaphorical thinking is vital in problem-solving by connecting mathematical concepts to everyday life (Annizar & Zahro, 2020).

Metaphorical thinking is based on a conceptual transfer of relations or mapping from a well-known source domain to a poorly known target domain, which can lead to innovative results in the sciences (Sanchez-Ruiz et al., 2013). The metaphor connects two conceptual domains: the origin domain and the target domain. The origin domain is usually more concrete, and the target domain is usually more abstract. Thus, by thinking metaphorically, students are asked to connect natural phenomena with the two domains, which will create a mathematical model, and students are expected to be able to solve the problem. In this study, Metaphorical thinking used Siler's *CREATE* criteria (1996). The *CREATE* criteria are connected, relate, explore, analyze, transform and experience. Based on Siler's description: (1) connect; connecting two or more different things, both objects and ideas, (2) relate; associating a difference between both objects and ideas to things from what we already know or are familiar with, starting with observing the similarities, (3) explore; explore similarities, draw ideas, build models, role-play, and describe the model, (4) analyze; analysis of things that have been thought of, therefore, it is necessary to rephrase existing ideas and models to find the relationship between these ideas and models, (5) transforms; recognize or discover something new based on connection, exploration, and analysis and (6) experience; apply images, models, or inventions to as many new contexts as possible.

Learning mathematics, especially algebra, is becoming an essential part of elementary school mathematics, allowing students to develop more thinking skills. Furthermore, learning algebra in elementary school is critical for bringing consistency, depth, and strength to the mathematics curriculum, as well as a step toward making this mathematical subject accessible to all students and preparing them for algebra in later grades (van den Heuvel-Panhuizen et al., 2013). This research paper will explain how the subject uses metaphorical thinking after solving algebra problems. It is

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interesting to examine the subject of metaphorical thinking to give us an overview and insight into how thinking metaphorically can be applied in solving mathematical problems.

METHOD

This research is qualitative research using a descriptive approach. This research involved one of the seventh-grade students in a private junior high school in Surabaya. VII graders of junior high school were chosen as research subjects because the students of that class had received algebra material in class VII of junior high school. The initial selection of research subjects by giving students a mathematical ability test is adopted from the national exam questions and completed in the form of a description or short answer. The taking of research subjects using the purposive sampling technique. In this study, one student was taken who had obtained a high score on the results of the mathematics ability test. Then after the research subject was selected based on the mathematical ability test, the research subject was given a problem-solving task. The problem-solving stages used in this study used the Polya problem-solving stages; understanding the problem, devising a plan, carrying out the plan, and looking back at the process.

The problem-solving task in this study was used to determine how the students' metaphorical thinking processes in solving algebraic problems were in the form of description questions. In this study, one problem-solving task was used. Here is the problem (Noviani, 2016).

> *Aisyah and Zahra got a skill assignment from school to make cakes. Aisyah has managed to make 5 cake pans. Meanwhile, Zahra has managed to make 2 cake pans. The amount of cake filling in each pan is the same. Then, Aisyah got an additional 3 pieces of cake from her sister and Zahra got an additional 18 pieces of cake from her mother. If it is known that the total number of Aisyah and Zahra's cakes is the same, then:*
>
> *a. Describe or make a parable of the problem above in a more understandable form!*
> *b. Determine how much cake is in 1 cake pan!*
> *c. Write a new problem according to the mathematical model obtained from the problem above!*

The researcher determined the indicators of metaphorical thinking based on the *CREATE* criteria adopted from Walfurqan's research (Walfurqan, 2015).

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Table 1. Indicators of Metaphorical Thinking and Stages of Problem Solving

Problem Solving Stages (Polya)	**Metaphorical Thinking Process**	**Indicator**
Understanding the problem	*Connect*	Exploring suitable metaphors from the given algebra problem
	Relate	Finding a metaphorical relationship with a given algebra problems
	Explore	Explaining things that are known and things that were asked of the problem
	Analyze	Rereading metaphors related to algebra problems
	Transform	Explaining new ideas that have been discovered
	Experience	Re-explaining the meaning of algebra problems
Devising a plan	*Connect*	Explaining the metaphors that have been found in solving algebraic problems
	Relate	Describing the characteristics of metaphor to the problems of algebra
	Explore	Explaining the mathematical model plan will be designed
	Analyze	Choosing the operations and methods to be used in solving mathematical models
	Transform	Explaining plan the steps to be taken to solve the problems
	Experience	Explaining the possible final results that will be obtained
Carrying out the plan	*Connect*	Choosing and summarizing the appropriate metaphor for the given algebra problem
	Relate	Explaining the statements of the problems of algebra and statements of metaphor
	Explore	Designing a mathematical model of the problem
	Analyze	Explaining the steps that have been done
	Transform	Writing the solution steps and results in mathematical symbols
	Experience	Making and explaining statements which are interpretations of the results of problem solving
		Writing and explaining another problem according to the designed model
Looking back at the process	*Connect*	Rereading/explaining the suitability of the metaphor made
	Relate	Explaining metaphorical statements with statements in algebra problems
	Explore	Explaining or retell conformity with the problems of mathematical models
	Analyze	Reading and explaining again every part of the process that has been done
	Transform	Checking and ensuring the final solution obtained by substituting it into a mathematical model
	Experience	Describing the application of the model or image of the new problems

The problem-solving test is used in the research validation process by the validator. Furthermore, interviews were conducted to confirm the results of the problem-solving written test. In this study, researchers used time triangulation to ensure the credibility of the data obtained. Time triangulation is done by giving the same questions at different times. Time triangulation was carried out after two weeks from the initial research and was carried out once. The research subject was given one problem-solving task question. Data analysis in this study is to transcribe data, reduce data, validate data, present data, and draw conclusions.

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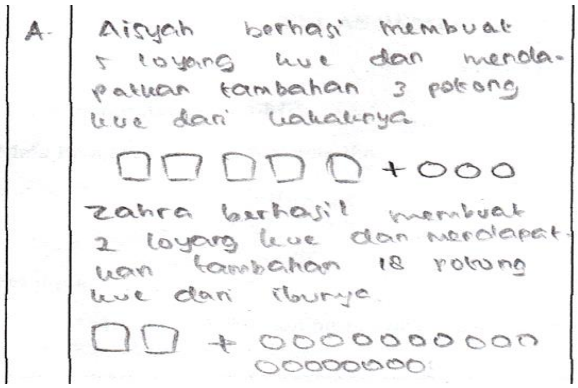
RESULTS AND DISCUSSION

Understanding the Problem

The first step in solving the problem in the Polya model is understanding the problem. Based on the algebraic problem given, the research subject wrote the information shown in Figure 1.



Aisyah made 5 cups of cake and got 3 pieces from her sister.

Zahra made 2 cups of cake and got 18 pieces from her sister.

Figure 1. The Research Subject's Understanding of the Problem Given

Based on the subject's answer results, the subject only describes the boxes as cake pans and circles as cakes. The subject does not assume the problem in another form. It was confirmed by interviews conducted by the researchers on the subject. In the interview excerpt, R stands for the researcher, and S stands for the research subject.

R : What information did you find from this question?
S : Aisyah managed to make 5 cake pans, Zahra made 3 cake pans, Aisyah got 3 extra cakes, Zahra got 18 extra cakes, and they had the same number of cakes.
R : Then what is asked of this question?
S : a. Describe the problem above in a more understandable form!
b. Determine how much cake is in 1 pan!
c. Write a new problem according to the mathematical model obtained from the problem above.
R : What do you think this issue is related to?
S : One variable linear equation material.
R : Can you describe the problem above in another form? For example, linking it to daily life
S : Here, Sis, I make the boxes as pan, the small circle as the cake (while showing the picture)
R : Why is it made like that?
S : So that I can easily remember the problem, so I made it in the form of boxes like this.
R : Hmm, if, for example, this problem is made in another form, for example, is related to daily life, can it be?
S : Hmm, I don't know.

From the interview excerpts and information notes in Figure 1, here are the *CREATE* criteria of research subjects in the stage of understanding the problem of problem-solving tasks (see Table 2).

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Table 2. The *CREATE* Criteria of Understanding the Problem

Problem Solving Stages (Polya)	***CREATE* Criteria**	**Metaphorical Thinking Data on Problem Solving Tasks**
Understanding the problem	*Connect*	Just describe the boxes as cake pans and circles as cakes. The subject does not assume the problem in another form. The subject does not find a metaphor that fits the problem
	Relate	Can't find the relationship between examples or other forms of algebra problems
	Explore	The subject explains what things are known and what is asked
	Analyze	The subject re-explains the information that has been obtained previously on the algebra problem and mentions the material that is appropriate to the problem.
	Transform	The subject only explained the picture of squares and circles as a new idea of the algebra problem.
	Experience	The subject re-explains the meaning of the algebra problem.

The subject's profile is metaphorical thinking in solving algebraic problems in the stage of understanding the problem. It can be seen from the interview results that the subject could not state the problem with metaphorical statements. The subject only describes a simple picture. The subject did not assume the problem in other forms and did not find any relational or other forms of this algebraic problem. However, the subject explained what things were known and asked. Furthermore, the subject re-explained previously obtained information on the algebra problem and mentioned the material that is appropriate to the problem. The subject could classify the problem into mathematical material, namely linear equations of one variable.

Devising a Plan

From the results of interviews at the stage of devising a plan, the subject could still not state the algebra problem in a metaphorical statement. The subject only gave an example with a simple picture as a cake pan that she understood from the problem. The interviews on the subject of research at the stage of devising a plan can be seen below.

R : So, what is your plan to solve this problem?
S : Initially, from this problem, I made a boxed picture, and from that picture, I made a mathematical model
R : How do you model it?
S : The problem is read and understood first. After that, I make what I know by describing cake pans. Then I model it into a mathematical model
R : Then what is the plan?
S : From this model, it is done to get how many cakes are in 1 cake pan
R : Do it by using the operation?
S : Hmmm, yes, Sis.
R : What operation?
S : Add, subtract and divide operations.
R : Please, try to explain the problem in your language
S : So Aisyah has 5 cake pans, then she gets 2 extra cakes. Zahra got 2 cake pans. Then she got 18 extra cakes. The number of their cakes is the same.
R : So, from what you explained, can you imagine this problem can be described in another form or is it related to everyday life to solve this problem?
S : I made pictures of boxes as cake pans and circles as cakes, Sis.
R : Are there other forms?
S : I don't know, Sis.
R : Hmm, about question b, do you already know your final result?
S : The result will be a number, for example, with x

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R : If for question c?
S : The new problem is made according to the model I made earlier

From the interview excerpts above, here are the *CREATE* criteria of research subjects in the stage of devising a plan of problem-solving tasks (see Table 3).

Table 3. The *CREATE* Criteria of Devising a Plan

Problem Solving Stages (Polya)	***CREATE* Criteria**	**Metaphorical Thinking Data on Problem Solving Tasks**
Devising a plan	*Connect*	The subject only describes a simple picture in this algebra problem
	Relate	The subject does not explain the characteristics of the metaphorical statement on algebraic problems
	Explore	The subject explains the plan of the mathematical model to be designed.
	Analyze	The subject determines the operation to be used in solving the mathematical model.
	Transform	The subject explains the steps that will be taken in solving the problem
	Experience	The subject explains the description of the final results that will be obtained in questions b and c

The subject profile of the metaphorical thinking in solving algebraic problems in the stage of devising a plan, the subject only illustrated a simple picture in this algebra problem, and the subject connected the figure as an idea found in the algebra problem. However, the subject described a mathematical model plan used in algebraic problems. The subject tells the plan of steps that will be taken in solving the problem. The subject could determine the operations to be used in algebraic problems. The subject also mentioned an overview of the final results to be obtained.

Carrying Out the Plan

The subject was at the stage of carrying out the plan. The subject was able to solve algebraic problems according to the plan. Meanwhile, in the answer sheet, the research subject solves the problem in the form of:

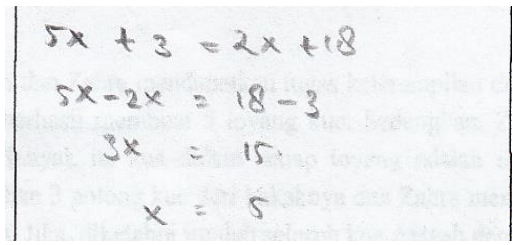

Figure 2. The Research Subject's Answers on Carrying Out the Plan

It was also confirmed by the results of the interview with the subject, which can be seen below.

R : As you said earlier, the problem is modeled first into a mathematical model. Please state the mathematical model
S : 5x + 3 = 2x + 18
R : What is x?
S : x is a variable that I assume as many cakes in 1 pan Sis.
R : Please try to re-explain the mathematical model you made!
S : Aisyah has 5 cake pans. It is 5x. Then she adds 3 cakes. It's 5x + 3. Zahra's has 2 cake pans. It is 2x, then 18 cakes are added, and 2x +18.
R : Then?
S : Solved using mathematical operations
R : Next?
S : 5x + 3 = 2x + 18

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5x – 2x = 18 – 3
3x = 15
x = 5

R : x = 5. What does it mean?
S : 1 cake pan contains 5 cakes
R : Whose 5 slices of cake are it?
S : Hmm, I could have Aisyah, could also have Zahra.
R : Can you design a new problem that fits the model from the previous mathematical model?
S : I can, Sis. For example, Ahmad bought 5 packs of books and got an additional 3 books from his brother. Meanwhile, Faiz bought 2 packs of books and 18 books from his sister.

From the interview excerpts and information notes in Figure 2, here are the *CREATE* criteria of research subjects in the stage of carrying out the plan of problem-solving tasks (see Table 4).

Table 4. The *CREATE* Criteria of Carrying Out the Plan

Problem Solving Stages (Polya)	***CREATE* Criteria**	**Metaphorical Thinking Data on Problem Solving Tasks**
Carrying out the plan	*Connect*	The subject does not determine a suitable metaphor for the algebra problem
	Relate	The subject does not explain statements from algebraic problems and statements from metaphors
	Explore	Subject created mathematical models of problems of algebra
	Analyze	The subject re-explains the steps that have been done previously
	Transform	The subject writes the completion steps and the results of the work in mathematical symbols
	Experience	The subject explains a new problem that is following the previously designed model

From Table 4, it can be seen that the subject was able to design a mathematical model of the problem. The subject was also able to explain the steps that have been taken in solving the problem. Furthermore, the subject wrote the completion steps and the final solution in mathematical symbols. The subject made a new problem that fits the previously designed model.

Looking Back at the Process

In looking back at the process, the subject could explain the stages of completion that have been done at the stage of carrying out the plan. The subject explained the mathematical model's applicability to the problem. Furthermore, the subject explained the application of the model to a new problem. It can be seen in the following interview results.

R : Please try to explain again the completion steps that you did from the beginning
S : I read the problem first, then after I read it, I made a picture of the cake pan, then made a mathematical model, and continued to solve it.
R : For question c, what about the new problem you created?
S : Look at the previous model, then build according to that model.
R : Are you sure about your previous answer? How to check it?
S : Sure, Sis, Aisyah has 5 cake pans plus 3 cakes, the same as Zahra has 2 cake pans plus 18 cakes.
R : Okay, then, with the new problem you have designed. Does it match the mathematical model that you made earlier?
S : Yes, it is appropriate. Ahmad bought 5 packs of books and got 3 books from his brother. Meanwhile, Faiz bought 2 packs of books and 18 books from his sister. So 5 packs of books plus 3 books are 5x + 3. Then 2 packs of books plus 18 books are 2x + 18.
R : Next?
S : The result is the same as the previous equation, x = 5

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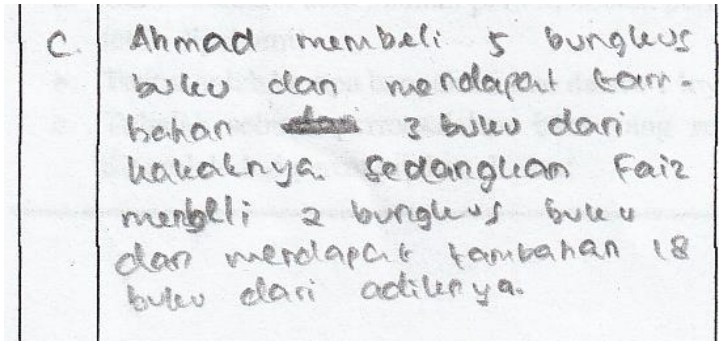
Meanwhile, in the answer sheet, the research subject created new problems in the form of:



Ahmad bought 5 packs of books and received an additional 3 books from his brother. Faiz bought 2 packs of books and received an additional 18 books from his sister.

Figure 3. The Research Subject's Answers on Looking Back at the Process

From the interview excerpts and information notes in Figure 3, here are the *CREATE* criteria of research subjects in the stage of looking back at the process of problem-solving tasks (see Table 5).

Table 5. The *CREATE* Criteria of Looking Back at the Process

Problem Solving Stages (Polya)	***CREATE* Criteria**	**Metaphorical Thinking Data on Problem Solving Tasks**
Looking back at the process	*Connect*	The subject does not have a metaphorical statement, so there is no need to explain the suitability of the metaphor with algebraic problems
	Relate	The subject does not explain the metaphorical statement with the statement in the algebra problem
	Explore	The subject re-explains the suitability of the mathematical model with the problem
	Analyze	The subject re-explains each part of the process that has been carried out.
	Transform	The subject rechecks the final solution obtained verbally
	Experience	The subject explains the application of the model to a new problem

The research subjects carried out the four steps of Polya's problem solving; understanding the problem, devising a plan, carrying out the plan, and looking back at the process, but for each step, the subject has not been optimal in revealing the *CREATE* criteria for metaphorical thinking. The research subjects did not reveal the Connect and Relate criteria in the four problem-solving steps and criteria *CREATE* metaphorical thinking. The subject only draws simple pictures that she uses as information to work on the next steps. The subject could not find a suitable metaphor for this algebra problem. In contrast to Walfurqan's research, the subject revealed the *Connect* criteria in metaphorical thinking. The subject was able to metaphorize algebraic problems. He described problems such as the scales in a balanced state (Walfurqan, 2020). As well as Wahyu's research stated that the research subject relates the given problem to the weekly saving process, making ladders and farmer's hats (Wahyu et al., 2020). In this study's algebra problem, the metaphor that can be used is to describe the problem in the form of a balanced scale; then another form is the traditional game of seesaw, but the subject has not been able to find metaphors related to algebra problems in this study.

However, although the subject has not been able to find metaphors related to this algebra problem, the subject was able to solve this algebra problem. It can be seen in the *Explore* criteria, designing a mathematical model on an algebraic problem. Setiawan's research supports this fact. At

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the *Explore* stage, the subject makes a model following the given problem-solving task (Setiawan, 2016). For the *Analyze* criteria, the subject was able to determine the mathematical operations used to solve the problem, and the subject was also able to explain the steps she did before. Research conducted by Wahyu stated that, on the criteria of *Analyze* of metaphorical thinking, the two subjects could re-explain the steps that had been taken previously (Wahyu et al., 2020). The subject revealed the *Transform* criteria by inferring and interpreting information based on previously done. Last, the subject revealed the *Experience* criteria by describing a new problem according to the previously designed model. In the *Experience* criteria of metaphorical thinking, students could apply their understanding by determining new problems similar to those given (Arni, 2019).

Based on the research data, metaphorical thinking is characterized by connecting abstract ideas to more tangible objects. Metaphorical thinking connects models and interpretations, allowing students to explore their knowledge while learning mathematics. Students' learning processes become more relevant because they can perceive the connections between concepts they are learning and concepts they are already familiar with (Komang & Febriyanti, 2020). Therefore, metaphorical thinking becomes vital in learning mathematics because mathematical concepts are abstract.

In this study, the research subject's ability to think metaphorically is moderate because the research subject was only able to describe algebraic problems in a simple form. The results of interviews and observations by Nurfitri and Mardiana of educators in one junior high school in Sumedang stated that students had learning difficulties connecting mathematical concepts with real life. The ability to think metaphorically is still low. One of the reasons is that most students consider mathematics a difficult and tedious subject (Nurfitri & Mardiana, 2019). The ability to inspire interest and improve students' learning motivation is one of the essential functions of metaphors in learning. It is intended that by being able to think metaphorically in learning activities, students will better understand the real-life situations they will experience, allowing them to improve their learning.

CONCLUSION

Based on the results of the analysis and discussion on the profile of metaphorical thinking in solving algebraic problems, it can be concluded that the subject completed Polya's problem-solving steps. However, for each step, the subject has not been optimal in revealing the *CREATE* criteria for metaphorical thinking. The research subject has not been able to find a suitable metaphor for the algebra problem, so the subject did not reveal the *Connect* and *Relate* criteria. However, the subject revealed *Explore* criteria by designing mathematical models on an algebraic problem. The subject was able to determine the mathematical processes needed to solve the problem for the *Analyze* criteria, and the subject was also able to explain the procedures taken before. The subject discovered the *Transform* criteria by inferring and interpreting data based on earlier work. Last, the subject

revealed the *Experience* criteria by explaining a new challenge using the model that had been created previously.

The findings of this study imply that teachers should assist students in problem-solving steps and develop metaphorical thinking skills. Other researchers who will examine students' metaphorical thinking profiles are expected to maximize their research by correcting the limitations that have been revealed in this study. The choice of material and questions can also be varied to reveal students' metaphorical thinking profiles.

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