



**THE ROLE OF SCAFFOLDING IN STUDENTS' GEOMETRY
ANALOGICAL REASONING FROM GENDER**

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Abstrak

Tujuan penelitian ini adalah untuk mengetahui: (1) proses penalaran analogi mahasiswa dalam geometri sebelum diberikan scaffolding ditinjau dari gender dan (2) proses penalaran analogi mahasiswa dalam geometri setelah diberikan scaffolding ditinjau dari gender. Metode penelitian yang digunakan dalam penelitian ini adalah studi kasus. Penelitian ini dilakukan pada mahasiswa yang sudah menempuh atau mengambil mata kuliah geometri dasar dan geometri analitik, mahasiswa semester 4 Program Studi Pendidikan Matematika IKIP PGRI Pontianak. Subjek yang diambil dalam penelitian ini berjumlah dua orang (laki-laki dan perempuan) dan memiliki kemampuan sedang. Alat pengumpulan data yang digunakan adalah tes dan wawancara (untuk mengetahui proses penalaran analogi mahasiswa). Sebelum mahasiswa diberikan scaffolding, terlebih dahulu mahasiswa diberikan tes penalaran analogi kemudian dilanjutkan dengan wawancara dan scaffolding. Teknik analisis data yang digunakan dalam penelitian ini adalah reduksi data, penyajian data, dan kesimpulan. Berdasarkan hasil penelitian dan pembahasan maka dapat disimpulkan bahwa (1) penalaran analogi mahasiswa laki-laki sebelum diberikan scaffolding hampir masuk pada tahap mapping artinya tahapan mapping mahasiswa masih kurang sedangkan penalaran analogi mahasiswa perempuan hanya pada tahap inferring, (2) setelah diberikan scaffolding, baik mahasiswa laki-laki maupun perempuan sudah melewati empat tahap dari proses penalaran analogi dari tahap encoding, inferring, mapping dan sampai pada tahap applying. Dengan demikian, adanya scaffolding memberikan pengaruh terhadap penalaran analogi mahasiswa.

Kata kunci: gender, penalaran analogi, scaffolding.

Abstract

The purpose of this study is to find out: (1) the process of reasoning analogy of students in geometry before being given scaffolding in terms of gender and (2) the process of reasoning analogy of students in geometry after being given scaffolding in terms of gender. The research method used in this research is a case study. This research was conducted on students who have taken basic geometry and analytic geometry courses, 4th semester students of the Mathematic Education Study Program, IKIP PGRI Pontianak. The subjects taken in this study amounted to two people (male and female) and had moderate ability. The data collection tools used were tests and interviews (to determine the analogy reasoning process of students). Before students are given scaffolding, students are first given an analogy reasoning test then followed by interviews and scaffolding. Data analysis techniques used in this research are data reduction, display and conclusion. Based on the results of the research and discussion, it can be concluded that (1) the analogy reasoning of male students before being given scaffolding almost entered the mapping meaning that the mapping stage of students was still lacking while the analogy reasoning of female students was only at the inferring, (2) after being given scaffolding, both male and female students have gone through four stages of the analogy reasoning



process from the encoding, inferring, mapping stage applying Thus, the existence of scaffolding has an influence on students' analogical reasoning.

Keywords: *gender, analogical reasoning, scaffolding.*

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INTRODUCTION

In solving a problem, good reasoning is needed. Therefore, a person solving mathematical problems quickly and precisely and his life depends on the reasoning. Gorys (2007) explains that reasoning is a thought process that tries to link known facts to get a conclusion, while Brodie (2009) reveals that when a person is reasoning, he has developed his thoughts to achieve goals, convince people and himself about something, solve problems or integrate several ideas into a more coherent whole. In practice, there are many types of mathematical reasoning. One of mathematical reasoning is analogical reasoning. Analogical reasoning is generally defined as the transfer of structural information from one system, the base, to another, the target system (Gentner in English & Sharry, 1996). This transfer of knowledge is achieved through a matching or mapping process, which requires finding the relational correspondence between the two systems. Sternberg in English (English, 2004) reveals four components of the analogical reasoning process: (1) encoding (identifying the characteristics of the problems of source and target), (2) inferring (looking for the relationship that exists in the problems of source and target), (3) mapping (determining the similarity relationship between the source problems and the target problems, then concluding the similarities between both, and (4) applying to determine the appropriate strategy to solve the target questions.

If students' analogical reasoning is still low, it will cause low problem solving abilities (Rozenchwajg, 2003). Learning by paying attention to analogical reasoning is considered effective (Loc & Uyen, 2014). It has an urgent role in problem solving, creativity, decision making, explanation and communication (Lancor, 2014). From several research results indicate that analogical reasoning is needed by students in problem solving. This means that if the reasoning of students and undergraduate students is good, it will affect problem solving. The role of analogical reasoning in mathematics establishes and finds solutions to a problem (Isoda & Katagiri, 2012). But the results of the study show that students still make mistakes and have difficulty in solving problems related to analogical reasoning such as these research results (Ardani & Ningtyas, 2017; Fauzi et al., 2020; Pang & Dindyal, 2009; Ratnaningsih et al., 2022; Wardhani et al., 2016). Therefore, we need a way to correct the weakness of their analogical reasoning. One way that can be done is by providing scaffolding especially on the concept of geometry. Özerem (2012) reveals that good geometry learning can hone thinking and reasoning skills (analogical reasoning) and Magdaş (2015) explains that analogical reasoning can be applied to geometry. This research wants to know the analogy reasoning process of undergraduate students (prospective teacher) who will later educate, teach and develop their students' analogical reasoning. How can an educator develop the reasoning of his students if his analogical reasoning is still low. Thus, it is very important to know the analogical reasoning process of undergraduate students and develop them because they are prospective teachers who will later teach and educate their students.

Scaffolding is defined as providing assistance to students based on need (Wood et al., 1976). The concept scaffolding is an important technique to bridge the gap between what students can achieve independently and what they can achieve with the help of others (Dagoc & Tan, 2018). Peretz (2006) also concluded in his research that the provision of scaffolding can improve the attitude of reasoning

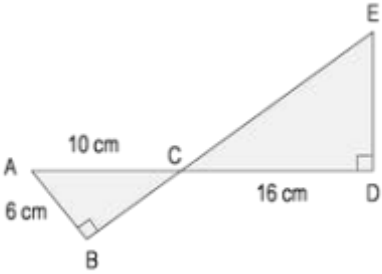
from the perspective of mathematics teachers and analogical reasoning is part of reasoning. Furthermore, the research results of Wu et al. (2016) also reveals that scaffolding affects reasoning, there is a difference between students' reasoning before and after being given scaffolding.

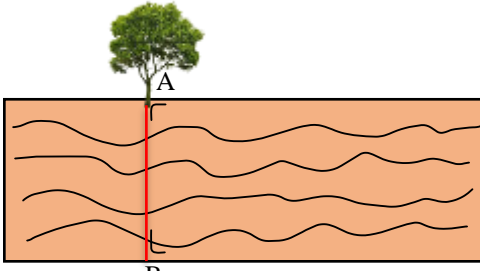
Santrock (Untarti & Subekti, 2016) states that gender has an effect on learning outcomes. The influence of gender in mathematics is due to biological differences in the brain between men and women, from observations it is known that boys are superior in mathematics, especially their spatial abilities, while girls are superior in language and writing (Geary et al., 2000). Experts have different views regarding the influence of gender in the field of mathematics, this is something that is still uncertain between men or women who are superior. The results of the study (Halat, 2008) showed that there was no statistically significant difference with reference to the level of geometric thinking between male and female mathematics teachers on the geometry test. Furthermore, the results showed that gender had no effect on the students' geometric thinking level (Novitasari et al., 2021). Research result of Nugraha (2020) shows that gender has no significant effect on mathematical reasoning abilities. The results of previous studies showed that gender had no effect on the geometry level. In addition, several other research results show that there is no difference in mathematical thinking in terms of gender (Hodiyanto, 2014, 2017). Therefore, researchers will continue with further research on analogical reasoning in geometry in terms of gender. The aims of this research are: (1) the students' analogical reasoning process in geometry before given scaffolding from gender and (2) the students' analogical reasoning process in geometry after given scaffolding from gender.

METHOD

The research method in this research is a case study. This research was conducted on students who have taken basic geometry and analytic geometry courses, 4th semester students of the Mathematics Education Study Program, IKIP PGRI Pontianak. The subjects taken in this study were two people (male and female) and had moderate abilities based on the results of previous geometry courses because students with moderate abilities had the highest distribution compared to others. The data collection tools used were tests and interviews (to determine the analogy reasoning process of students). Interviews were conducted to reveal students' analogical reasoning as well as provide scaffolding to students. Before students are given scaffolding, students are first given an analogical reasoning problems then followed by interviews and scaffolding. Scaffolding in this study is a assistance to students to solve problems by giving other problems of the same type and asking them to be solved and looking for relationships between source problem and target problems. Researchers will guide students in questions so that students automatically find relationships and answer to the questions given. After that, students were asked to take the analogy reasoning problem again. Data analysis techniques used in this research are data reduction, data display and conclusion. The instruments used in this study can be seen in table 1.

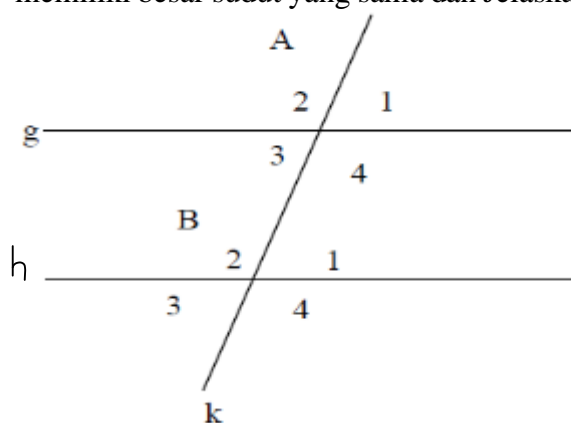
Table 1. Analytical Reasoning Instruments

No	Source Problem	Target Problem
1	<p>Dari soal berikut tentukan panjang DE!</p> 	<p>Seorang mahasiswa ingin mengukur lebar suatu sungai. Coba jelaskan bagaimana cara mahasiswa tersebut menghitung lebar sungai seperti yang diilustrasikan gambar di bawah ini (A adalah pohon di seberang sungai dan B adalah tempat posisi mahasiswa)!</p>

No	Source Problem	Target Problem
		

2 Perhatikan gambar di bawah ini. Jika dua garis sejajar dipotong oleh garis ketiga, maka terdapat hubungan beberapa sudut di dalamnya. Tentukan sudut A dan B yang memiliki besar sudut yang sama dan Jelaskan!

Buktikan bahwa jumlah sudut-sudut dalam segitiga sama dengan sudut lurus!



RESULTS AND DISCUSSION

The research results that will be presented in this article are the research results relating to students' analogical reasoning before and after given scaffolding. The subjects in this study consist of one male (M) and one female (F) who all have moderate abilities.

Analogous Reasoning Process before Given Scaffolding

Based on student M answers, it was found that they are correct in solving the first source problem and based on the results of the interviews they also understand that it is related to triangle congruence. Furthermore, the results of the answers of first target problem show that student M is still wrong in answering the questions given as the answers can be seen in Figure 1. The argument built by M is not clear and the use of the concept of congruence is also inappropriate. Student only tries to answer the question and knows that it is not true because he does not know how to solve it.

His second source answer (in figure 2) is found that he has tried to show the same angle in the given question but only at angle A (vertical angle in A) and have not shown the same angle between angles A and B. Similarly, when solving the target problem (figure 3), student M is still wrong in proving and has not been able to utilize the concept to be conveyed in the source question. Based on the results of the interview from problems, the analogy reasoning process starts from encoding to identify problems of source and target, then student M is also inferring to look for the relationship between both source and target and try to solve them (but still not thorough because they only see the vertical angle in A). At the mapping (determining the same relationship between the source and the target problem), student M has not been able to identify that the source problem and target problem have a relationship, student M has not found the relationship that proving the number of angles in a triangle of 180° is using the relationship of two angles of the same size (correspond or alternate) so that when applying he has not been able to find the right idea to solve. Thus, the analogy reasoning process of student M (male) with moderate ability before given scaffolding almost at the mapping but has not yet reached the mapping because it is still low in finding the relationship between the problems of source and target.

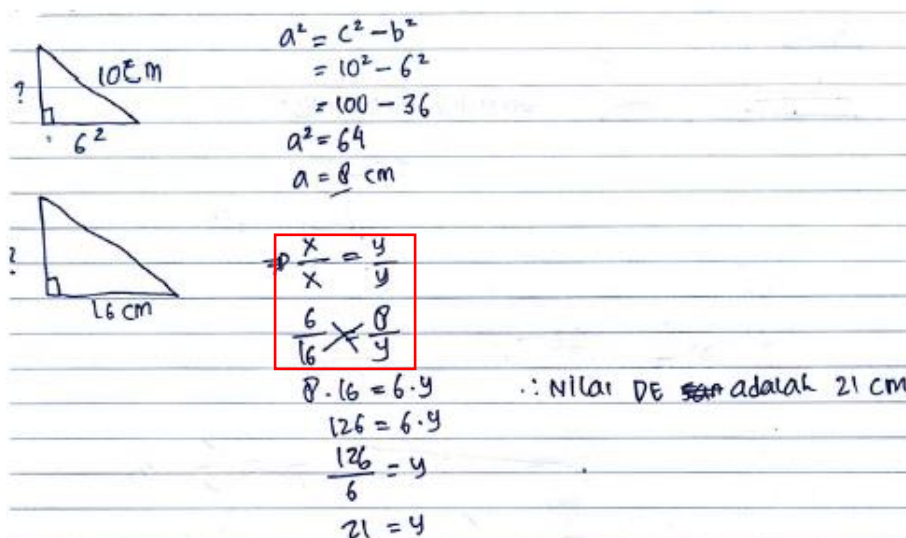


Figure 4. The First Source Answer (F)

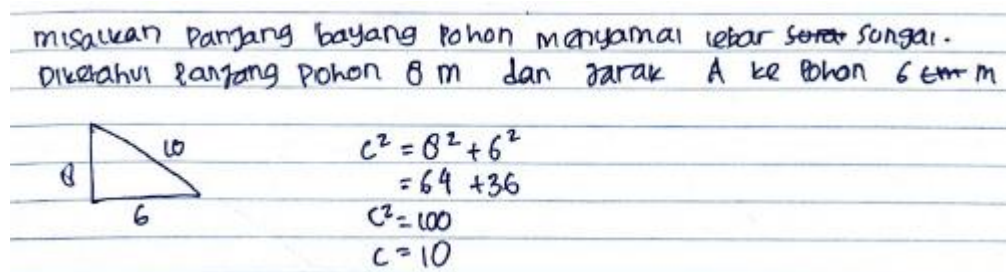


Figure 5. The First Target Answer (F)

Furthermore, the first source answer results of student F (female) can be seen in Figure 4. This student's answer is still wrong even though it is true that she has used the concept of similarity but she is wrong in determining the corresponding side. Based on the results of the interview, it is found that student F considered side AB to correspond to CD and BC to correspond to DE, whereas AB side should correspond to DE and BC to correspond to CD. Furthermore, in Figure 5 she assumes the width of the river is the same as the shadow of a tree even though the tree is on the other side of the river which does not allow students to cross. Based on the results of the interview, student M no

longer has any ideas for solving the target problem.

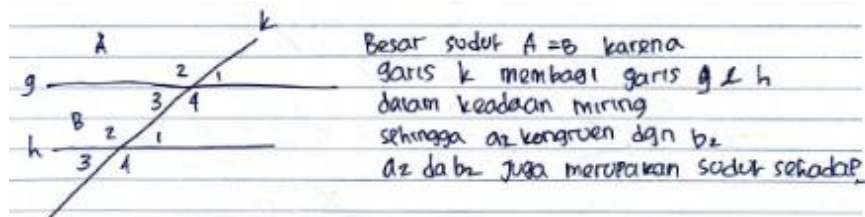


Figure 6. The Second Source Answer (F)

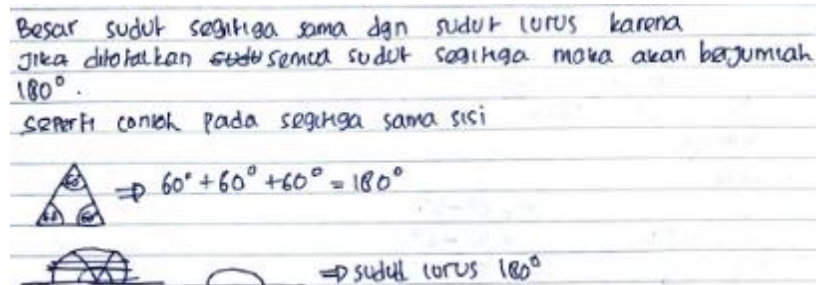


Figure 7. The Second Target Answer (F)

Based on second source answer (Figure 6), it is found that student F has shown that angle A_2 corresponds to angle B_2 although there are still many angle relationships that are not explored. Furthermore, student M has not been able to complete second target problem and her answer can be seen in Figure 7 (wrong answer). Then, from the interview results from the two problems that are worked, it is found that student F do encoding to identify both to make it easier to solve questions, then student F also inferring to find the relationship between the source problems and target problems, student F already knows the concept in source problems and be able to solve them. At the mapping (determining the same relationship between the source and target problems, student F has not found a relationship between the two questions, so when applying, she has not been able to find the right idea to solve. Thus, student F analogy reasoning process (women) with moderate ability before given scaffolding only reached the inferring and had not yet reached the mapping stage.

Analogous Reasoning Process after Given Scaffolding

The results of the study or answers of students' analogy reasoning problems after given scaffolding will be presented. Scaffolding in this study is a assistance to students in solving problems by providing guidance (questions) in answering questions of the same type as the questions given. Before given scaffolding, both students M and F have been able to solve the first source problems well. It's just that they haven't found a relationship between the first source and target problems. However, after given scaffolding there are changes in the answers given by students, both students M and F as shown in Figure 8 and Figure 9. The interesting thing about the answers of the two students is the different ways used and both are correct. Even though they use different methods and examples, but their final result are the same, finding a river width of 12 meters (m not cm to be precise).

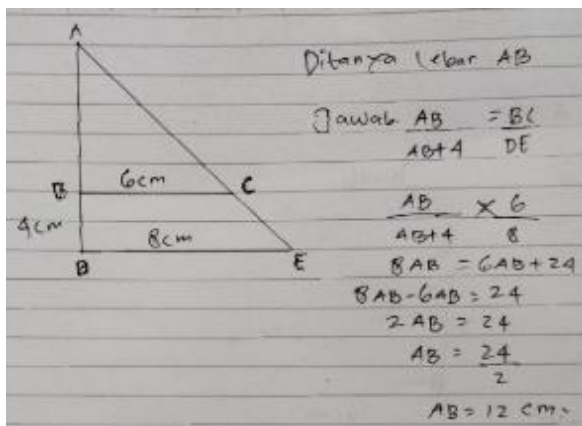


Figure 8. The First Target Answer (M)

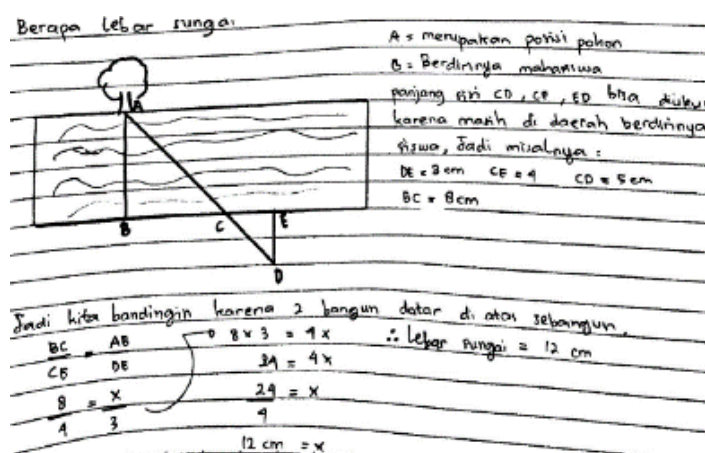


Figure 9. The First Target Answer (F)

Next, from the answers of second problem, both student M and student F give the same answer. This means that they are able to show all angles that are the same size between angle A and angle B, only that the term used by student M is not correct, which should use the term of alternate interior or alternate exterior angles but he uses the term interior alternate or exterior alternate angles (a term that is rarely found) as is in figure 10. Furthermore, both students A and B have been able to solve the target problems (in figure 11) although there are some things that need to be clarified such as where the parallel lines appear from. At the time of the interview, two students have not been able to explain or guarantee that the parallel lines were in accordance with the rules or axioms in geometry such as the axioms of parallelism in geometry. But they have been able to use the source problem (correspond or alternate angles) to prove that the sum of the angles in the triangle is 180° .

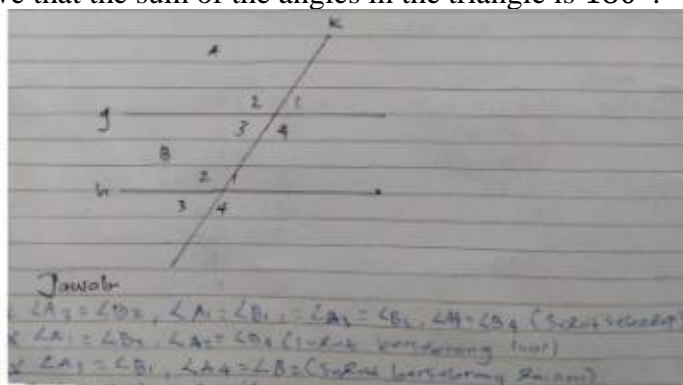


Figure 10. The Second Source Answer (M)

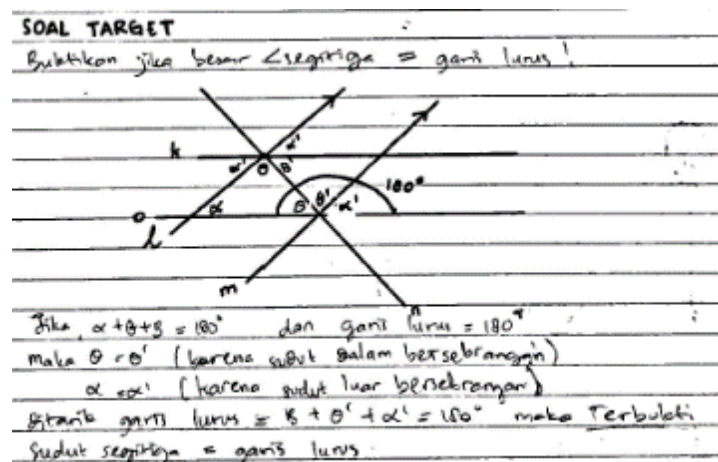


Figure 11. The Second Target Answer (F)

Based on the results of answers and interviews of students, it is found that after given scaffolding, both students M and F in the analogy reasoning process have reached the applying stage. Encoding (identifying source questions and target questions) both student M and B are able to identify the questions given (what are known and what are asked from the questions). Inferring (looking for the relationship contained in the problems of source and target), both are able to find and find the relationship correctly from the two given problems. The mapping (determining the same relationship between the problems on the left and the right or building conclusions from the similarity of the relationship between the two problems, two students are able to find the similarity relationship and are able to conclude them so that they were able to determine the correct way of solve the target problem (applying). Thus, after given scaffolding, the student's analogy reasoning process reaches the applying stage. This is in accordance with the findings of Mozzer & Justi (2012) that analogical reasoning is also influenced by different sources of information received by students and undergraduate students such as from teachers, what discussed in class and the strategies used. Scaffolding includes assistance provided to students which affects students' analogical reasoning. In addition, Peretz (2006) also concluded that the provision of scaffolding can improve the attitude of reasoning from the perspective of mathematics teachers. Analogous reasoning is part of reasoning. The results of the research by Sari et al. (2016) concluded that the provision of scaffolding can overcome reasoning difficulties. The research results of Wu et al. (2016) also revealed that scaffolding affects reasoning, there is a difference between students' reasoning before and after given scaffolding.

CONCLUSION

Based on the results of the research and discussion, it can be concluded that (1) the analogical reasoning of male students before given scaffolding almost entered the mapping, the mapping stage of students was still lacking while the analogy reasoning of female students was only at the inferring, (2) after given scaffolding, both male and female students have gone through four stages of the analogy reasoning process from the encoding, inferring, mapping, and applying. Thus, the existence of scaffolding has an influence on students' analogical reasoning. The results of this study need to be followed up, especially regarding the relationship between analogical reasoning and abstraction. Because when students look for the relationship between source problems and target problems, abstraction is needed. Abstraction is taking or paying attention to important traits and ignoring/aborting unimportant traits (Soedjadi, 2000; Van Oers, 2007). In addition, for further research, the instruments made should be different between before and after scaffolding. The instruments are different but have the same weight.

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