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ANALOGICAL REASONING PROCESS OF PROSPECTIVE TEACHERS TO PRODUCE NON-ANALOG PROBLEMS

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Abstract

Prospective teachers often have difficulty in posing problems. This indicates unsuccessful analogical reasoning, so prospective teachers produce non-analog problems. Therefore, a study is needed to trace the process of unsuccessful analogical reasoning of prospective teachers so that they can produce non-analog problems. The research aims to describe the analogical reasoning process of prospective teachers that causes prospective teachers to produce non-analog problems. The research method used a case study with a qualitative approach. The participating research subjects were prospective teachers from one of the universities in Sidoarjo, East Java, Indonesia. The research subjects are prospective teachers who are asked to generate analog problems but produce non-analog problems. The research instruments included analog problem posing tasks and interviews. The analogical reasoning process of prospective teachers can be traced through process components or activities in terms of retrieval, structuring, representation, mapping, application, and verification. Prospective teachers generate non-analog problems, starting with inappropriate activities in object retrieval and source problem solving. The structuring and representation of analog source objects were not successfully done by prospective teachers, resulting in non-analog problems. This impacted the next activities, namely mapping, application, and verification which were unsuccessful in producing solutions to analog target problems.

Keywords: Analogy; non-analog problems; problem posing

Abstrak

Calon guru seringkali mengalami kesulitan dalam mengajukan masalah. Hal ini menunjukkan penalaran analogi yang tidak berhasil, sehingga calon guru menghasilkan masalah non-analog. Oleh karena itu, dibutuhkan suatu penelitian untuk menelusuri proses ketidakberhasilan penalaran analogi calon guru sehingga dapat menghasilkan masalah non-analog. Tujuan peneltian adalah untuk mendeskripsikan proses penalaran analogi calon guru yang menjadi sebab calon guru menghasilkan masalah non-analog. Metode penelitian menggunakan studi kasus dengan pendekatan kualitatif. Subjek penelitian yang berpartisipasi merupakan calon guru dari salah satu Perguruan Tinggi di Sidoarjo, Jawa Timur, Indonesia. Dalam hal ini, subjek penelitian adalah calon guru yang diminta untuk menghasilkan masalah analog namun menghasilkan masalah non-analog. Instrumen penelitian meliputi tugas pengajuan masalah analog dan wawancara. Proses penalaran analogi calon guru dapat ditelusuri melalui komponen proses atau aktivitas dalam hal pemanggilan, penataan, representasi, pemetaan, penerapan, dan pemeriksaan. Calon guru menghasilkan masalah non-analog diawali dengan aktivitas tidak tepat pada pemanggilan objek-objek dan penyelesaian masalah sumber. Penataan dan representasi objek-objek sumber yang analog tidak berhasil dilakukan calon guru, sehingga menghasilkan masalah non-analog. Hal ini berdampak pada aktivitas berikutnya, yaitu pemetaan, penerapan, dan pemeriksaan yang tidak berhasil untuk menghasilkan solusi dari masalah target yang bersifat analog.

***Kata kunci**: Analogi; masalah non-analog; pengajuan masalah*

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INTRODUCTION

Analogical reasoning can fulfill one's need to achieve understanding, as experts do (Bartha, 2019; Richland & Begolli, 2016). Teachers who teach mathematics with analogies can benefit from not only the transfer of procedural knowledge but also the transfer of conceptual knowledge and flexibility of thinking for students (Richland & Begolli, 2016; Vamvakoussi, 2019). In relation to problem posing, analogical reasoning is needed to reformulate the original problem into a new problem (Fitriana et al., 2022; Saleh et al., 2020).

Several previous studies revealed the virtues of researching problem posing by involving prospective teachers. Osana and Pelczer (2015) and Kojima et al. (2015) conveyed that problem posing for prospective teachers is needed to support mathematics professional development and beliefs that are oriented towards preparing prospective teachers to become future teachers. According to Xie and Masingila (2017), research on prospective teachers in posing problems can provide information on concept misconceptions and support prospective teachers in posing problems to make more sense. In addition, teachers can use it to evaluate their pedagogical knowledge and teaching (Matitaputty et al., 2024; Zayyadi et al., 2020).

Prospective teachers have some problems when posing problems. Kojima et al. (2015) said that although prospective teachers had been trained to pose problems through problem examples, they struggled to understand the key ideas underlying the problems. Leavy and Hourigan (2020) revealed prospective teachers still have a limited conception of posing quality problems. Li et al. (2020) state that prospective teachers experience uncertainty in posing and teaching students through problem posing.

Successful analogical reasoning in posing problems is characterized by generating analog problems, while unsuccessful analogical reasoning is characterized by generating non-analog problems (Fitriana et al., 2022). Non-success in generating non-analog problems is due to one's failure to transfer the structure or set of solutions from the source to the target problem (Kojima et al., 2015). In addition, it is common for people to transfer analogies by focusing on surface similarities rather than identifying problem solving similarities (Minervino et al., 2017; Singer & Voica, 2017).

Experts use process components to trace specific problem situations or phenomena, but process components to trace analogical reasoning in posing problems are still not available. Therefore, a process component needs to be built from the opinions of Sternberg (1977), Novick & Holyoak (1991), and Ruppert (2013), i.e.: (1) retrieval, (2) structuring, (3) representation, (4) mapping, (5) application, and (6) verification.

Existing studies have not focused deeply on exploring the analogical reasoning process of prospective teachers who produce non-analog problems. Several studies conducted by Kristayulita et al. (2020), Pupo et al. (2019), and Kojima et al. (2015) have the closest similarity with this study. Kristayulita et al. (2020) use the analogical reasoning process component but not for problem posing. Pupo et al. (2019) and Kojima et al. (2015) focus on using analogies in problem posing during learning.

Based on the descriptions above, successful analogical reasoning of prospective teachers is characterized by

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generating analog problems as a future-oriented teacher competency. Unfortunately, prospective teachers generally generate non-analog problems when reasoning analogically. Therefore, A study is needed to explore the process of unsuccessful analogical reasoning of prospective teachers in generating non-analog problems. This is useful for exploring the components or causes of prospective teachers' failure to pose analogical problems to avoid posing non-analogical problems. Hence, this study aims to describe the analogical reasoning process of prospective teachers that causes prospective teachers to generate non-analogical problems.

RESEARCH METHOD

The research used a qualitative case study to explore prospective teachers' analogical reasoning in posing non-analog problems. The exploration emphasized prospective teachers' analogical reasoning in the retrieval process components, structuring, representation, mapping, application, and verification.

The research participants were prospective teachers at a university in East Java Indonesia. The research participants were 10 prospective teachers who could solve the source problem but could not pose the problem, resulting in a non-analog problem. All participants had already received permutations as the underlying material for the source problem.

Data collection was done by using an analog problem-posing task instrument. This analog problem posing task has one source problem. Furthermore, the source problem is used as initial information for prospective teachers to pose analog problems, as shown in Figure 1.

> Dari 50 mahasiswa dalam suatu kelas, terdapat 10 mahasiswa yang memenuhi syarat untuk dipilih menjadi pengurus kelas. Pengurus kelas yang akan dipilih terdiri atas satu orang ketua kelas, satu orang wakil ketua kelas, satu orang sekretaris, dan satu orang bendahara. Pengurus kelas yang terpilih tidak boleh merangkap jabatan. Tentukan ada berapa banyak cara susunan pengurus kelas yang mungkin terbentuk?

Figure 1. Source problem

Prospective teachers were instructed to solve the source problems on the instrument, and then prospective teachers were asked to pose three analog problems as target problems. Furthermore, prospective teachers who failed in posing analog problems or posed non-analog problems were further traced their analogical reasoning using interviews. This was necessary to reveal the analogical reasoning of prospective teachers in posing non-analog problems. The disclosure emphasized on the descriptors of analogical reasoning process components in terms of retrieval, structuring, representation, mapping, application, and verification (Novick & Holyoak, 1991; Ruppert, 2013), as Table 1.

Table 1. Analogical reasoning components and descriptors

Components	Descriptor
Retrieval	Retrieving each object and problem context in the source problem or other objects in memory to be placed as objects of the target problem.
Structuring	Building alignment between target problem objects and source problem objects
Representation	Constructing a target problem that has a relationship with the source problem

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Components	Descriptor
Mapping	Aligning the similarity of the target problem solving method with the source problem solving method
Application	Applying the solution method to the target problem
Verification	Evaluating the similarity of target objects with source objects

Data analysis was conducted in five stages. First, grouping the correct answers to the source problem. Second, grouping the answers regarding the problem and non-analog target problem solving. Third, transcribing interview data of subjects who posed non-analog problems. Fourth, reducing and focusing the analogical reasoning of prospective teachers who consistently posed at least two non-analog problems based on process components. Fifth, it summarizes the analogical reasoning process of prospective teachers in posing non-analog problems.

RESULTS AND DISCUSSION

The results showed that of the 10 prospective teachers who posed non-analog problems, two subjects consistently posed at least two non-analog problems. The first and second subjects who performed analogical reasoning were coded as AM and DS.

AM's analogical reasoning

AM's presentation and analysis were based on the written work and interview transcripts. Figure 2 shows AM's solution to the source problem.

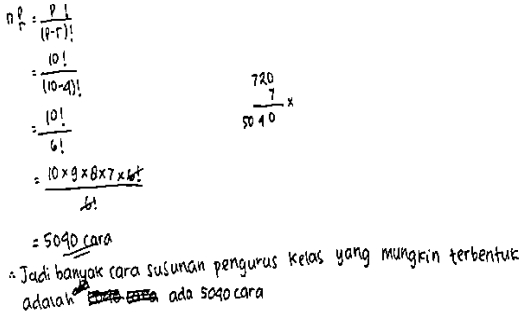

Figure 2. AM source problem solving

In the retrieval activity, AM identified the objects of the source problem by reading the source problem and relating it to the instructions. During the interview, AM could not mention the objects of the source problem that were connected or based on the concept of permutation, but AM's written work showed the use of the permutation formula.

The permutation formula used was not correct in its writing, AM wrote $\frac{p!}{(p-r)!}$. Then, in nPr, AM assumed that n was the permutation symbol and p was the number of students. However, AM calculated $\frac{10!}{(10-4)!}$ correctly to determine the many ways to organize the class. During the interview, AM recalled formulas and solutions from discrete subjects. Furthermore, AM generated the 1st and 2nd target problem ideas regarding selecting Olympic participants and HIMA (student union) members. AM thought of these ideas because there are elections in the Olympics and HIMA, such as the election of class officers.

In the structuring activity, AM came up with the objects of the target problem by equating some of the numbers in the source problem. AM adjusted it to the idea of selecting Olympic participants or HIMA members. In the 1st target problem, 50 students and 10 students are the same objects in the source problem. Class

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management becomes the selection of National Olympiad participants, 4 class administrators do not double up to 3 randomly selected, and determining many board arrangements becomes the determination of possible ways to form.

In the 2nd target problem, 50 students and 10 students are the same objects as the source problem and the 1st target problem. The class management becomes the selection of HIMA members, 4 class administrators do not double up to 5 randomly selected, the determination of many board arrangements becomes the determination of many ways to determine members.

AM did not realize that the problem condition, namely "3 or 5 randomly selected" would cause the arrangement of Olympic participants or HIMA members to be an arrangement that did not pay attention to the order. AM also assumed that choosing randomly would be the same as the 4 class officers in the source problem. In other words, AM gave a condition that was not a condition of the permutation problem. AM considered this condition because she remembered a similar problem in a discrete math course. Therefore, AM did not make the correct overall analogies to the source problem. This resulted in the objects of the target problem not being connected by the same concept as the source problem. During the interview, AM said that the Olympic participants should have consisted of 4 instead of 3 participants, and the members of HIMA should have been 4 instead of 5 members. This means that AM considers that the analogies made must be the same overall from the source problem.

AM assembled objects to build the representation activity's 1st and 2nd target problems. AM modified the sentence wording to assemble these objects and equalized the sentence order as the source problem. However, AM did not give specific sentence wording to the target problem questions to better fit the setting or context of the problem; for example, in the 1st target problem, AM wrote "determine how many ways there might be". AM also changed the term "one class" to "a class". AM reasoned that one class was more appropriate because it was the same as the source problem. In other words, in constructing the target problem, AM equated the use and order of sentences based on the source problem. At the end of this activity, AM produced two non-analog problems. Figure 3 and Figure 4 show the 1st and 2nd non-analog problems by AM, respectively.

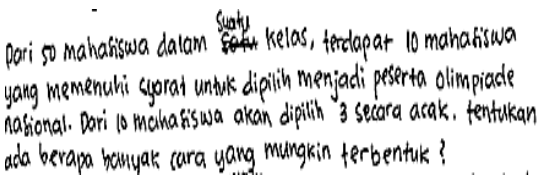
Dari 50 mahasiswa dalam ~~satu~~ Suatu kelas, terdapat 10 mahasiswa yang memenuhi syarat untuk dipilih menjadi peserta olimpiade nasional. Dari 10 mahasiswa akan dipilih 3 secara acak. tentukan ada berapa banyak cara yang mungkin terbentuk ?

Figure 3. 1st AM non-analog problem

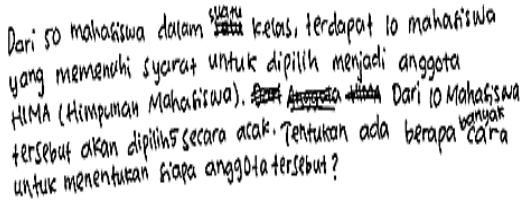
Dari 50 mahasiswa dalam ~~satu~~ kelas, terdapat 10 mahasiswa yang memenuhi syarat untuk dipilih menjadi anggota HIMA (Himpunan Mahasiswa). ~~Dari Anggota dipilih~~ Dari 10 Mahasiswa tersebut akan dipilih 5 secara acak. Tentukan ada berapa banyak cara untuk menentukan siapa anggota tersebut ?

Figure 4. 2nd non-analog problem AM

In the mapping activity, AM compared the steps of solving the source problem to the steps of solving the 1st and 2nd non-analog problems. Before providing the solution steps, AM equated the plan of how to solve the 1st and 2nd non-analog problems by looking at how to solve the source problem. However, AM did not realize that the plan for solving the problem differed from how the source problem was solved. In other words, AM did not

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perform the mapping activity appropriately in identifying the solution plan and comparing the suitability of the solution method between the source and target problems. Figure 5 and Figure 6 show AM's non-analog problems solution of the 1st and 2nd.

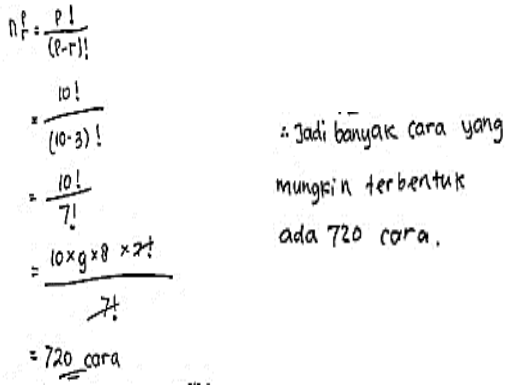

Figure 5. AM 1st non-analog problem solving

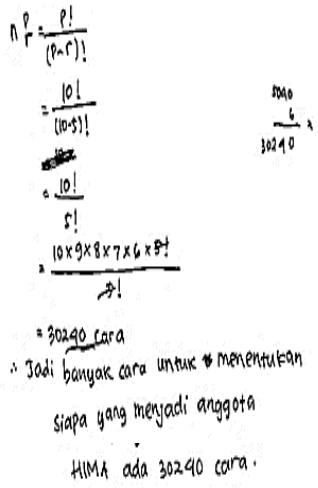

Figure 6. AM 2nd non-analog problem solving

In the application activity, AM solved the 1st and 2nd non-analog problems by using the permutation formula to solve the source problem. AM used the permutation formula $P(n,r)$ or the permutation of r objects from n objects. In the 1st non-analog problem, AM substituted the permutation 3 of 10 students into $\frac{p!}{(p-r)!}$, so it became $\frac{10!}{(10-3)!}$.. The same was done for the 2nd analog problem, resulting in $\frac{10!}{(10-5)!}$. AM did not give the exact way of solving it, but the resulting problem did not require that the order be observed. In other words, AM did not perform the application activity appropriately because AM could not connect the use of concepts that should be the same as the source problem in proposing and solving the problem.

In the verification activity, AM verified the 1st and 2nd non-analog problems he constructed by re-reading. AM also checked the non-analog problem's solution through the method's suitability with the source problem. AM reasoned that the method matching was done to check the use of the same concept. AM did not realize the discrepancy between the problem and the non-analog solution. Therefore, in this activity, it can be said that AM performed three forms of inappropriate verification activities, namely on the verification of the problem, problem solving, and the suitability of the target problem to the source problem.

Based on the analysis above, AM's analogical reasoning contains inappropriate analogies, resulting in non-analog problems. Inappropriate analogies are found in generating problem conditions. AM gave conditions that caused the formed arrangement to ignore the order.

DS's analogical reasoning

DS's presentation and analysis were based on his written work and interview transcripts. Figure 7 shows the solution of the source problem by DS.

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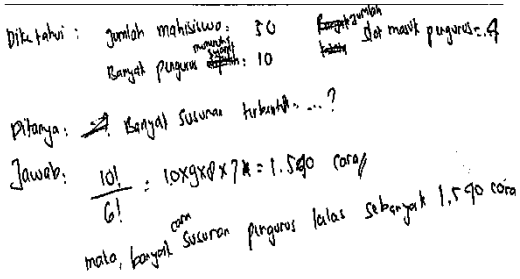

Figure 7. DS source problem solving

In the retrieval activity, DS identified the connectedness of the objects of the source problem. In this, DS explained that the source problem had the concept of permutation. Still, when asked about the definition of permutation, DS thought that permutation had a different order and that repetition was allowed. When asked further about important objects or information, DS could mention one of the conditions as a characteristic of permutation problems, namely, the caretaker cannot duplicate, but after DS reflected on what had been said, DS was unsure whether the concept of permutation or combination was more appropriate.

During the interview, it can be seen that DS provides a way of solving through the permutation formula. DS wrote $\frac{10!}{6!}$, this solution was based on the permutation of 4 out of 10. After solving the source problem, DS thought of similar problems from experience and previous problem references. DS devised the idea of the 1st and 2nd target problems regarding ball and number plate retrieval. DS said that he had solved problems with taking balls and license plates during lectures.

In the structuring activity, DS came up with the objects of the target problem. DS modified some objects in the source problem to bring up the objects in the target problem. In the 1st target problem, 10 students become 15 different colors of balls, and 4 class management positions become 2 balls taken randomly. In the 2nd problem, the class management became a motorcycle plate. During the interview, DS confirmed that randomly picking 2 balls in the 1st target problem and 7 characters of plate arrangement (letter W, 4 number characters, 2 vowel characters) were not based on the source problem. Still, DS came up with objects sourced from similar problems obtained during lectures. The target problem objects in the 2nd target problem are also based on the suitability of license plates in Sidoarjo. DS modified the W plate into 7 characters of letters and numbers.

During the interview, DS also confirmed that he was confused about choosing the concept of permutation or combination. This shows that DS did not make analogies correctly so that the objects of the target problem that he appeared were not connected by the same concept as the source problem. In the 1st target problem, this inaccuracy started when DS came up with the condition of taking 2 balls randomly. If 2 balls are taken randomly, the formed arrangement does not consider the order. In the 2nd target problem, the inaccuracy starts when the DS does not give the condition that the plate arrangement should not be repetitive or without returns.

DS assembled the objects in the representation activity to produce the 1st and 2nd problems. DS confirmed that the arrangement of objects was done by adjusting some source problem information and permutation or combination problems that had been seen or solved previously in related references. In the 2nd target problem, DS also assembled the sequence of objects based on the suitability of the

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license plate sequence starting from the city code. In other words, DS constructed the target problem by appropriately adjusting the sentence wording and object order based on the source problem. Therefore, DS generates a problem that is conceptually different from the source problem, so the resulting problem is a non-analog problem. At the end of this activity, DS produced two non-analog problems. Figure 8 and Figure 9 show the 1st and 2nd non-analog problems by DS, respectively.

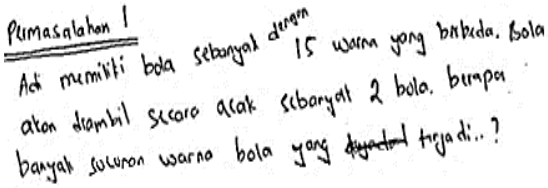

Figure 8. DS 1st non-analog problem

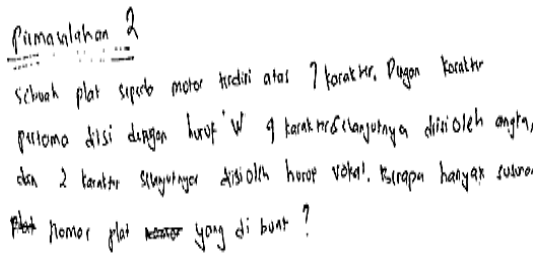

Figure 9. DS 2nd non-analog problem

In the mapping activity, DS did not compare the plan for solving the 1st and 2nd non-analog problems to the solution of the source problem. DS explained how to solve the target and source problems with the same concept: permutation or combination. In other words, DS did not provide the same solution plan as the way to solve the source problem using the permutation formula. Therefore, DS did not perform the mapping activity appropriately in identifying the solution plan and comparing the suitability of the solution method of the target problem to the source problem. Figure 10 and Figure 11 show DS's 1st and 2nd non-analog problem solving.

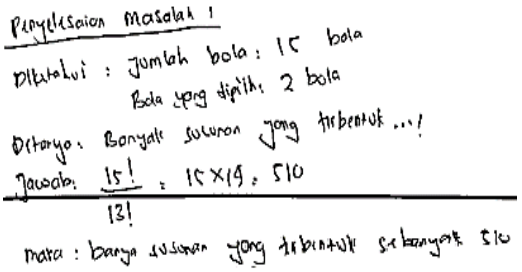

Figure 10. DS 1st non-analog problem solving

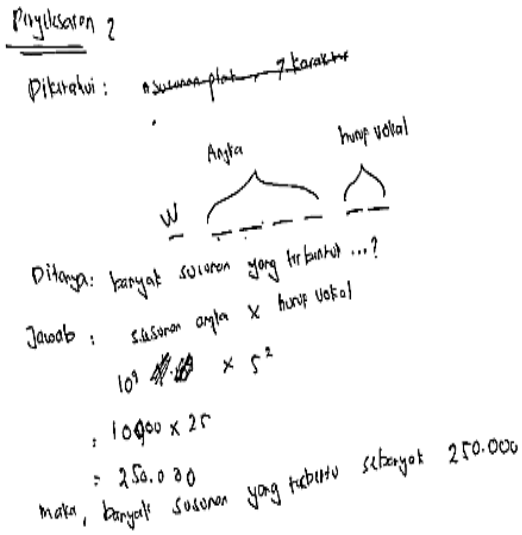

Figure 11. DS 2nd non-analog problem solving

In the application activity, DS applied the solution method in the 1st non-analog problem by using the permutation of 2 out of 15. This method is inappropriate because 2 balls taken randomly should have an arrangement regardless of the order. While in the 2nd non-analog problem by using the multiplication rule. During the interview, DS mentioned the multiplication rule as a way of reasoning. DS applied this method to the 2nd non-analog problem by arranging the letter W, 4 numbers, and 2 vowels so that the number of possible license plate arrangements is 10^4x5^2 or 250.000. In this, the 2nd non-analog solution

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produced by DS is correct because the target problem does not require numbers and vowels not to be repeated. During the solution process, DS changed 10^4 to 4^{10} and then to 10^4 to determine the many ways of arranging the license plate numbers. However, this 2nd non-analog problem solving is not appropriate or correct because it differs from the source problem, which should pay attention to the order and without returns. In other words, DS did not perform the application activity correctly because DS could not connect the use of concepts that should be the same as the source problem in proposing and solving problems. DS did not verify the problems and solutions of the 1st and 2nd non-analog problems in the verification activity.

Based on the analysis above, DS's analogical reasoning contains inappropriate analogies that result in non-analog problems. The inappropriate analogies are found in the conditions used in the 1st target problem or the incompleteness of the conditions given in the 2nd target problem. Therefore, DS cannot generate problems that pay attention to order and without returns as the source problems. Figure 12 visually depicts the analogical reasoning of prospective teachers in proposing non-analog problems based on the process component, while Table 2 is the coding of analogical reasoning activities based on the process component.

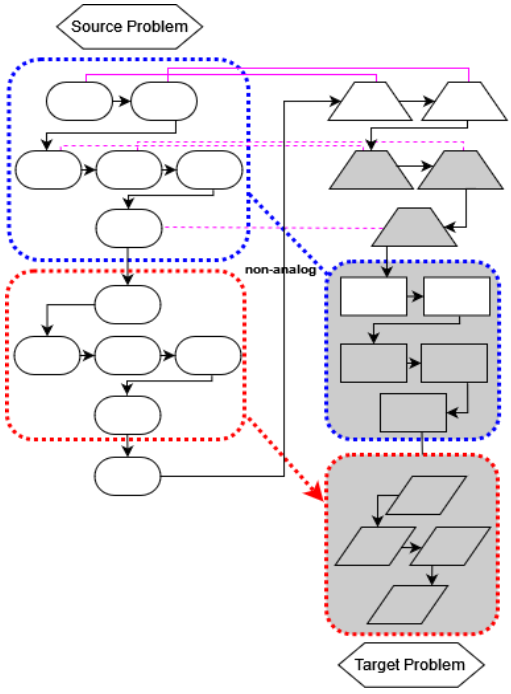

Figure 12. Analogical reasoning schemes that generate non-analogs

In the retrieval activity, the subject started the problem posing by identifying the relationship between the objects of the source problem to determine the concept underlying the problem. However, the subject could not correctly identify the permutation concept that connects the source problem's objects. In this, the subject experienced doubts about the concept of permutation or combination underlying the problem (Matitaputty et al., 2022;

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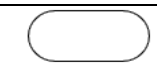
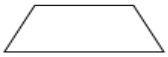
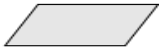
Sukoriyanto et al., 2016). One subject assumed n was the permutation symbol and p was the number of students. At the end of this activity, the subjects generated the target problem idea. Some subjects based their ideas not on the source problem but on similar problems during lectures. This is similar to the subject in the research of Singer et al. (2015), Saleh et al. (2017), and Pratiwi and Amir (2023), that the subject put aside the mathematical structure or context of the problem or its relationship to the problem situation.

Table 2. Analogical reasoning coding description

Code	Term	Code	Term
	Retrieval activity		Inappropriate retrieval activity
	Structuring activity		Inappropriate structuring activity
	Representation activity		Inappropriate representation activity
	Activity mapping		Inappropriate mapping activity
	Activity sequence		Inappropriate application activity
	Analogies to objects		Source or target problem
	Analogies to inappropriate objects		Mutually non-analog problem

In the structuring activity, the subject brings up the objects of the target problem. There is a subject who brings up objects based on the source problem, but this subject does not make analogies between objects appropriately. Other subjects bring up objects that are not based on the source problem. This can be shown by the subject who did not give the problem conditions appropriately so that the problem to be built is classified as having the concept of permutation. Kojima et al. (2015) revealed prospective teachers had difficulty understanding the problem's key ideas.

In the representation activity, the subject assembles objects to build the target problem. Some subjects provide sentence redactions that are not specifically related to the problem idea. This is because the subject equates the redaction of the target problem with the source problem. In addition, the subject did not realize the incompatibility of the target problem with the source problem. In this, the subject made transfer analogies by emphasizing the similarity of the problem in terms of the surface but not the structure or stages of the problem solution (Minervino et al., 2017; Singer & Voica, 2017). The problem generated by the subject is a non-analog problem. This problem is similar to one of the problems generated in the study by Palmér & van Bommel (2020), which found other problems that do not follow the original problem structure. This indicates the presence of negative transfer analogies, i.e., failure to transfer the information structure of the source problem to the target (Pratiwi & Amir, 2023), so the resulting target problem is non-analog (Minervino et al., 2017).

Subjects did not perform mapping activities appropriately in identifying the solution plan and comparing the suitability of the method and steps of solving the target problem to the source

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problem. This can be seen from one subject who did not realize that the resulting target problem solving method should differ from the source problem. Another subject did not provide a solution plan that was the same as the source problem's method. The subject did not perform application activities appropriately in applying the solution method to match the solution of the source problem (Nuridah & Amir, 2023; Pratiwi & Amir, 2023; Rochman & Amir, 2023).

In the verification activity, a subject verifies the target problem, its solution, and conformity with the source problem. However, this subject did not realize the discrepancy between the target and source problems and the solution. Other subjects did not perform verification of the target problem or its solution. The inappropriate mapping, application, and verification activities were partly due to the subject focusing on surface similarities rather than identifying similarities in problem solving, so the subject failed to transfer the structure or stages of solving from the source problem to the target problem (Kojima et al., 2015; Pratiwi & Amir, 2023; Singer & Voica, 2017).

Thus, this study's results imply that for prospective teachers to generate analog problems during the analogical reasoning process, prospective teachers must be successful in calling relevant problem objects. Next, organize the objects, so that they at least have the same initial problem structure or modify them into a new problem structure. Representing the resulting problem as a problem that does not have the exact same language as the original problem or has a different problem context is also needed. Next, mapping and applying the solution of the initial problem to the target problem is done to ensure the resulting problem is an analog problem. Finally, prospective teachers can examine the resulting target problem, namely regarding the relevant problem objects, problem structure, and problem solving, to guarantee that the resulting target problem is an analog problem.

CONCLUSION AND SUGGESTION

The analogical reasoning process of prospective teachers in generating non-analog problems can be traced through process components or activities in terms of retrieval, structuring, representation, mapping, application, and verification. As for the retrieval activity, (1) identifying objects or ways of solving the source problem inappropriately, (2) generating target problem ideas that are irrelevant or non-analog to the source problem. In the structuring activity, (1) generating target problem objects that do not have an appropriate relationship with the objects of the source problem, (2) identifying the relationship of target objects is not analog to the objects of the source problem. In the representation activity, (1) assembling non-analog problem objects, (2) generating non-analog problems. In the mapping activity, (1) identifying a plan for solving the target problem that is considered the same as the way to solve the source problem, (2) cannot compare the suitability of the way to solve the target problem with the way to solve the source problem, In the application activity, (1) establishing a way to solve the target problem that is different or non-analog to the source problem, (2) making a non-analog solution to the target problem. In the verification activity, (1) could not check the suitability of the target and source problems, and (2) could not check the

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suitability of the target and source problem solving.

The results of the study provide some suggestions. For future research, there is a need for a program or learning intervention that trains prospective teachers to propose or generate analog problems. In this, prospective teachers are trained and familiarized with distinguishing analog and non-analog problems, practicing problems or problem solving, and then problem posing.

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