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ANALOGY TRANSFER IN LEARNING NEW MATERIAL WITH AND WITHOUT INTERMEDIATE PROBLEM

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Abstrak

Transfer analogi merupakan transfer belajar yang memetakan pengetahuan dari masalah sumber ke masalah target. Transfer analogi dapat digunakan untuk mempelajari materi baru berdasarkan pengetahuan yang sudah ada sebelumnya. Penelitian ini bertujuan untuk menganalisis transfer analogi siswa dalam mempelajari materi baru dengan dan tanpa masalah antara. Masalah antara merupakan masalah yang memiliki tingkat kesulitan di antara masalah sumber dan target dengan penggunaan analogi yang sama. Masalah antara mungkin dapat berperan sebagai jembatan analogi ketika dalam transfer analogi dari masalah sumber ke masalah target mengalami kesulitan. Penelitian ini menggunakan metode campuran, metode kuantitatif dilanjutkan dengan metode kualitatif. Subjek sebanyak 45 siswa kelas X di SMA Swasta Gresik, kemudian dipilih 4 siswa sebagai subjek kualitatif. Data kuantitatif dianalisis berdasarkan persentase keberhasilan dan kegagalan siswa pada tiap kasus transfer analogi, sedangkan data kualitatif dianalisis berdasarkan fase transfer analogi yaitu penstrukturan, pemetaan, penerapan, dan pemeriksaan kembali. Hasil penelitian menunjukkan bahwa persentase keberhasilan transfer analogi pada siswa dengan masalah antara lebih besar daripada siswa tanpa masalah antara. Pada siswa dengan masalah antara dapat melakukan transfer analogi dengan baik di tiap fasenya. Sedangkan, pada siswa tanpa masalah antara mengalami hambatan pada fase penerapan. Siswa dengan dan tanpa masalah antara yang tidak dapat mengerjakan masalah target dengan benar mengalami kegagalan transfer analogi pada fase pemetaan.
Kata Kunci: Transfer analogi, materi baru, masalah sumber, masalah antara, masalah target.

Abstract

Analogy transfer is a transfer of learning knowledge from the source problem to the target problem. Analogy transfer can be used to learn new material based on pre-existing knowledge. This study aims to analyze the transfer of analogies in studying new material with and without intermediate problems. The intermediate problem is a problem that has a difficulty level between the source and target problems using the same analogy. The intermediate problem may be able to act as analogy bridges when having difficulty in the analogy transfer from the source problem to the target problem. This study uses a mixed-method with a quantitative method followed by a qualitative method. The subjects were 45 students of tenth grade class at Gresik Private High School, then 4 students were selected as qualitative subjects. Quantitative data were analyzed based on the percentage of student success and failure in each analogy transfer case, while qualitative data is analyzed based on each phase in the analogy transfer, namely structuring, mapping, applying, and verifying The results showed that the percentage of successful analogy transfer in studies with intermediate problems was greater than in students without intermediate problems. Students with intermediate problems can transfer analogies well in each process. Meanwhile, students without intermediate problems experienced obstacles in the applying process. Students who cannot work on the target problem correctly both experience the analogy transfer failure in the mapping phase.
Keywords: Transfer analogy, new material, source problem, intermediate problem, target problem.

INTRODUCTION

The analogy is a knowledge map based on looking at the general relationship of two situations (D. Gentner & Smith, 2012). The analogy according to Manuaba (2016), means comparing two things having similarities. The analogy is a thinking process in making conclusions from two things having similarities (Widiyatmoko, 2020). From these definitions, the analogy can be interpreted as knowledge mapping by comparing two similarities in different situations.

The analogy component consists of a source problem and a target problem (English, 2004). The source problem has characteristics that are, the problem is relatively easy, given before the target problem, and its solution can help in solving the target problem. Meanwhile, the target problem has characteristics that are, its structure is related to the source problem, relatively more complex, it can be in the form of developing source problems or new problems.

In the analogy, there is a bridge or a link between two problems, namely the source problem and the target problem which have similarities. An analogy bridge is a link to make it easier for students to understand new knowledge (Dwirahayu, 2018). In this case, the intermediate problem may be able as an analogy bridge when having difficulty in the analogy transfer from the source problem to the target problem. The intermediate problem is a problem that has a level of difficulty between the source and target problems using the same analogy.

Analogy transfer is the ability to transfer knowledge obtained from existing old knowledge to new knowledge (Casale et al., 2011). Analogy transfer is the fundamental structure transfer obtained through the source problem to the target problem (Klauer, 1989). Analogy transfer is an information transfer by mapping the problem source structure to the target (Alghadari & Kusuma, 2018). From these definitions, it can be concluded that analogy transfer is the fundamental structure transfer of existing knowledge to form a new analogous knowledge structure.

Analogy transfer is important for students to acquire new knowledge and solve non-routine problems based on routine problem-solving thinking (Manah et al., 2017). Analogy transfer has benefits in solving new problems in mathematics and outside mathematics (Azmi, 2019). It means analogy transfer has an important role to be able to help students learn something new with what they have learned from existing knowledge.

Analogy transfer occurs through the analogous thinking phase of knowledge about the source problem, mapping it to a new problem schema, then assessing similarities and comparing the two problems structure (Dedre Gentner et al., 1993; Nokes & Ohlsson, 2005). There are four phases of analogy transfer, which are structuring, mapping, applying, verifying (Ruppert, 2013). The structuring phase is the identification of each mathematical object in the target problem by coding it and drawing conclusions from the identical relationship between the source problem and the target problem. The mapping phase is a search for the relationship of similarities concepts between the source problem and the target problem and then build conclusions from the similarities or conceptual relationships between the source problem and the target problem. The applying phase is solving the target problem based on the source problem-solving steps. The verifying phase is an examination of the suitability of the answer to the target problem with the source problem.

Several previous studies related to analogy transfer were obtained, the success of analogy transfer occurred because of an understanding of the similarity of the schema of the source problem and the target problem (Mandler & Orlich, 1993). The success of analogy transfer also occurs because of the ease of knowledge information obtained from source problems to be applied in solving problems (Saifaddin, 2014). Meanwhile, the failure of analogy transfer occurs because there is no understanding that solving the source problem is related to solving the target problem (Wahyuningtyas, 2017). The failure of analogy transfer in learning something new can occur as a result of the distance between the source problem and the target problem so that students do not understand the similarity of the initial scheme and its solution.

Based on research results Muchsin et al. (2020) show that there are still many student errors in solving the problems of a linear inequalities system of two variables even though this material is a prerequisite material that must be mastered when learning linear programming material. This shows that there are still many students who do not understand the linear inequalities system of two variables. Transfer analogy can be used in studying the material because it has an analogous concept with a linear equations system of two variables, namely the intersection of sets.

Analogy transfer in studying the material can be made possible as a solution to overcome the failure of transfer of analogies from the source problem to the target problem. Research related to the use of intermediate problems in analogy transfer is still not available, so this research focuses on using intermediate problems in analogy transfer in studying new material to find out whether intermediate problems can bridge the analogy transfer.

METHOD

The research used mixed methods with a clear sequence design which is using quantitative methods followed by qualitative methods to explain quantitative results (Creswell & Plano, 2007). The purpose of using this method was to identify the components of the analogy transfer concept with intermediate problems and without intermediate problems through quantitative data analysis and expand the information through qualitative data analysis.

The subjects were forty-five students from two tenth grade class at Gresik Private High School. In the first class, twenty-three students were using the intermediate problem. In the other class, twenty-two students were not using the intermediate problem in solving the target

problem from the source problem. The target problem was related to the material of a linear inequalities system of two variables with the source problem chosen from the linear equations system of two variables material. Linear equations system of two variables choosing because this material has the same analogy in the system solution with linear inequalities system of two variables based on the set intersection concept. Each selected class has the same control variable which they have studied the material on the source problem and have not studied the material on the target problem. Then, each class will take one correct subject and one wrong subject to be interviewed regarding each analogy transfer phase so that there are four students as qualitative subjects. In the class with the intermediate problem, the correct subject was chosen with the criteria that can solve the source, intermediate, and target problems well. Meanwhile, the wrong subject was chosen with the criteria that can solve the source problem well but could not solve the intermediate and target problem. In the class without the intermediate problems, the correct subject was chosen with the criteria that can solve the source and target problem well. Meanwhile, the wrong subject was chosen with the criteria that can solve the source problem well but can not solve the target problem.

The research instrument was in the form of task-based interviews related to analogy transfer. The instrument development began with making source, intermediate, and target problems followed by making interview questions related to each phase in analogical reasoning. The task given in the form of an analogy transfer test included a source problem and a target problem, one class uses an intermediate problem when solving the two problems. The researcher made sure that the students worked on the assignment independently for thirty minutes in class. A related source problem draws a graph of a two-variable system of linear equations and shows the solution. The intermediate problem involved making a graph of a linear inequalities system and finding the solution. The target problem involved making a graph of a complex linear inequalities system and finding the solution.

Table 1. Question List

Problem Type	Question
Source Problem	Consider the following linear equations system : $2x + 3y = 18$ $x + 2y = 10$ Make graph of the linear equations system and show which one is the solution!
Intermediate Problem	Consider the following linear equations system : $x \geq 3$ $y \geq 2$ Make graph of the linear equations system and show which one is the solution!
Target Problem	Consider the following linear equations system : $3x + 2y \geq 6$ $4x + y \geq 4$ Make graph of the linear equations system and show which one is the solution!

The quantitative data were analyzed in the percentage of success and failure of analogy transfer in each case. The success of analogy transfer criteria can solve the target problem correctly based on analogous thinking from the source problem. Meanwhile, the failure of analogy transfer criteria can not solve the target problem. If the percentage of success in the class with intermediate problems was greater than the class without intermediate problems, then the intermediate problem can be one solution to bridge the analogy transfer. The largest percentage of failures in the analogy transfer phase was also shown to know which phase the teacher needed to focus on teaching using analogy transfer or focus in other studies. Qualitative data analysis did after quantitative data analysis. The initial research subjects were all students. Four subjects were selected with the criteria of one subject can solve the source and the target problems in each case and one subject being able to solve the source problem but unable to solve the target problem in each case. Subjects with these criteria were given interviews related to each phase in the analogy transfer, namely structuring, mapping, implementing, and re-examining. The qualitative analysis was carried out to find out how the analogy transfer phase with and without intermediate problems.

Table 2. Each Indicators of Analogy Transfer Phase

Phase	Indicators
Structuring	- Can mention all structure or concept on source and target problems - Can mention the same structure or concept of the source problem and the target problem
Mapping	- Can determine the right analogous relationship related to solving the target problem from the source problem

	- Can provide mathematical and logical arguments related to the analogy relationship
Applying	- Can mention the target problem-solving steps based on the source problem-solving structure - Can solve the target problem based on the correct analogy relationship
Verifying	- Can analyze the suitability of the steps made with the results after being applied to solving the target problem - Can create new problems that are analogous to the target problem

RESULT AND DISCUSSION

Result

The results related to the transfer of analogies in classes with intermediate problems and classes without intermediate problems, some students experienced success and failure. The number of students who succeed and fail in analogy transfer in each class is shown in the following table.

Table 3. Analogy Transfer Test Results

Class	Analogy Transfer			
	Success		Fail	
With Intermediate Problem	9	39,13%	14	60,87%
Without Intermediate Problem	5	22,73%	17	77,27%

Based on table 3, it can be seen that the class with intermediate problems in transferring the analogy to the source problem to the target, the number of successful work on the target problem is greater than the class without intermediate problems..

From the test results, success and failure subjects will be taken from the class with intermediate problems or without intermediate problems to analyze the answers to test results and interviews for each phase in the transfer of analogy. The division of the first subject to the fourth subject can be seen in the following table.

Table 4. Subject Description

Subject	Code	Description
First Subject	DMA-S	With intermediate problem, can solve source and target problem
Second Subject	DMA-G	With intermediate problem, can solve source, but can not solve target problem
Third Subject	TMA-S	Without intermediate problem, can solve source and target problem
Fourth Subject	TMA-G	Without intermediate problem, can solve source, but can not solve target problem

First Subject Data Analysis

The results of the subject's work on the analogy transfer test are shown in the following figures.

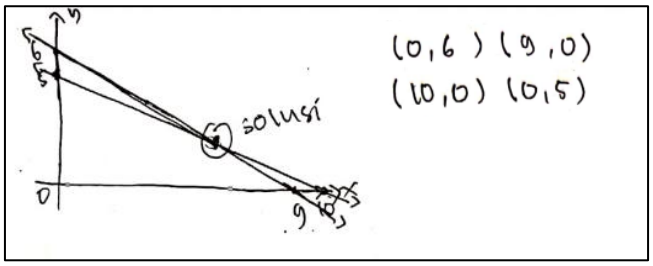

Figure 1. Result of DMA-S Work on Source Problem

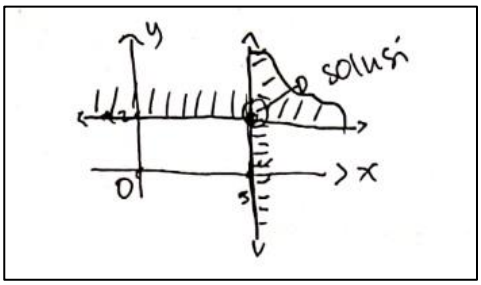

Figure 2. Result of DMA-S Work on Intermediate Problem

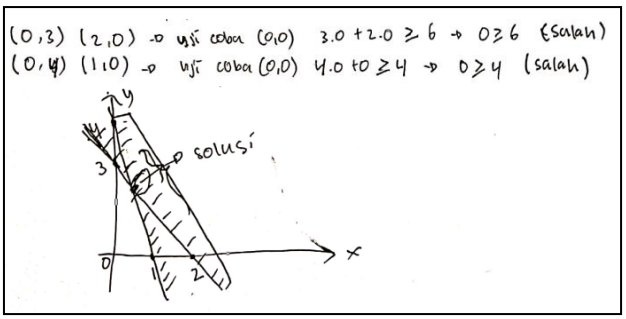

Figure 3. Result of DMA-S Work on Target Problem

Structuring Phase

Description of Interview Results

P : What do you think about solving problem number 1 (source problem)?

DMA-S1 : Remembering the material in junior high school, how to solve it by closing alternate variables (finding the intersection point of the x-axis and y-axis).

P : What do you think in solving problem number 2 (intermediate problem)?

DMA-S2 : Immediately make a line x = 3 and y = 2 (don't need two point because vertical and horizontal line).
P : What do you think about solving problem number 3 (target problem)?
DMA-S3 : Same with number 1, but there is a shading in solution.
P : Do the three questions have the same structure?
DMA-S4 : Solutions between numbers 2 and 3, with number 1 being the same at the intersection point (the subject shows that all three have the same solution at the intersection).

The subject shows that the concept contained in the source problem is related to the material of a two-variable linear equation system (Figure 1 and DMA-S1). The subject also shows that the concept contained in the intermediate problem is still related to the source problem because it is necessary to draw a line followed by shading the inequality (Figure 2 and DMA-S2). In addition, the subject mentioned that in solving the source and intermediate problem after drawing the graph, it was continued by showing the solution that was still related (DMA-S4). This shows that the subject can mention the concepts contained in the same concept in the source problem and the intermediate problem.

In solving the target problem, the subject shows that the concepts contained in the target problem were related to the intermediate and source problems (Figure 2 and DMA-S3). In addition, the subject states that in solving the problem, the intermediate and the target had the same form of solution (DMA-S4). It shows that the subject can mention the concepts contained in the same concept in the intermediate problem and the target problem.

Mapping Phase

Description of Interview Results

P : Are the three solutions related?
DMA-S5 : Related in finding the point (x, y) in the equation of the line.
P : What are the differences between the three solutions in terms of choosing a solution?
DMA-S7 : Solution in number 1 is only one point. Meanwhile, solution in number 2 and 3 is that it fulfills 2 shading.
P : Is the definition of a system solution the same in your opinion?
DMA-S18: Same, the value that satisfies the two elements in the system

The subject shows that in the relationship between the two problems, the solutions still have different forms (DMA-S5 and DMA-S7). The difference in solutions to the problem between those that are not only at the intersection point but there are many other points so that it is in the form of shading. The subject mentioned that the definition of the system solution to the source problem and between the same is related to the concept of set slices, namely the value that satisfies all the equations or inequalities in the system (DMA-S18). This shows that the subject can determine the right analogous relationship in the selection of solutions to the two problems and can provide logical mathematical arguments.

In solving the target problem, the subject shows that the intermediate and target problems have the same solution, namely in the form of shading obtained after drawing two shadings for each inequality (Figure 2 and Figure 3). The subject also explained that the solution to the intermediate problem and the target problem came from the analog concept, namely looking for areas that meet two shadings (DMA-S7 and DMA-S18). This shows that the subject mapped the solution based on the exact analog relationship related to the concept of the intersection of two sets.

Applying Phase

Description of Interview Results

P : How step to solve number 1?
DMA-S8 : Find 2 points in an equation to draw the line, then choose the point where the two lines intersect as the solution.
P : Why choose the intersection point as the solution?
DMA-S9 : Because for example choosing the one that doesn't intersect, now it's useless where the point of intersection
P : How step to solve number 2?
DMA-S12: Immediately draw the line vertically and horizontally, there is shading because it is an inequality. For example, the shading is only 1, the others don't have to be useless, so choose the two shading.
P : How step to solve number 3?
DMA-S15: Same as number 1 but different in a point test to determine shading, there is shading like number 2. Choose a solution that meets 2 shading the same as number 2.

Subject can apply source problem steps to intermediate problem solving with adjustments (DMA-S8 and DMA-S12). The adjustment lies in drawing graphs and in determining system solutions to problems between two shadings. Subject also showed that they could understand the structure of the source problem solving by mentioning arguments related to the choice of solutions (DMA-S9). It shows that the subject can solve the intermediate problem with the right analogous relationship and the steps are adjusted based on solving the source problem.

In solving the target problem, the subject shows the completion steps were adjusted from the previous problem, namely the source problem and the intermediate problem (DMA-S15). Step adjustment of the source and

intermediate problem when determining the shaded area and solution. It shows the subject can solve the target problem correctly and use the previously adjusted problem-solving steps.

Verifying Phase

Description of Interview Results

P : Are you working on the steps you mentioned or are there any additions?

DMA-S16: Yes, it's appropriate.

P : Did you get help when solving number 3, by solving numbers 1 and 2?

DMA-S17: Helped in taking the solution, in both shading like number 2. Helped at the intersection point as a solution.

P : Can you create a new problem whose solution is similar to the three numbers?

DMA-S19: You can just change numbers. In numbers 2 and 3, the inequality sign can be replaced.

Subject can analyze the suitability of the previously mentioned steps with what is done in each phase (DMA-S16). Subject can also create new problems that have analogous concepts with source and intermediate problems (DMA-S19). It shows that the subject can understand and ensure that the transfer of analogies made is correct.

In solving the target problem, the subject has re-examined the suitability of each of the previously mentioned steps with what is being done (DMA-S16). The subject explained that when working on the target problem, analog thinking on the intermediate problem and also the source problem was helped in drawing the solution as the intersection of two sets of solutions (DMA-S17). Subjects can also create new problems that are analogous to the previous problem (DMA-S19). It shows that the subject has understood the analog concept of the three problems and ensures the correctness of the analogy transfer that has been carried out.

Second Subject Data Analysis

The results of the subject's work on the analogy transfer test are shown in the following figures.

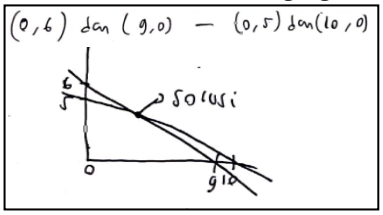

Figure 4. Result of DMA-G Work on Source Problem

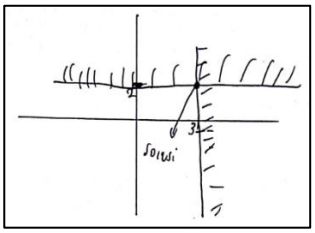

Figure 5. Result of DMA-G Work on Intermediate Problem

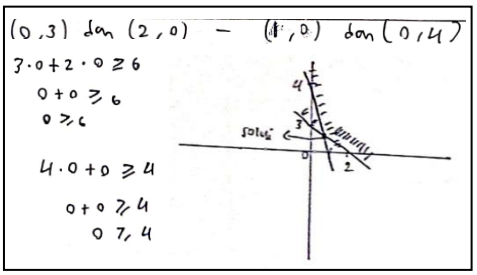

Figure 6. Result of DMA-G Work on Target Problem

Structuring Phase

Description of Interview Results

P : What do you think about solving problem number 1 (source problem)?

DMA-G1 : Taking two points from two equations, draw a line to the Cartesius.

P : What do you think in solving problem number 2 (intermediate problem)?

DMA-G2 : Draw a line vertically and horizontally and shade the two inequalities according to the inequality sign.

P : What do you think about solving problem number 3 (target problem)?

DMA-G3 : Same as number 1, draw a line through two points on the Cartesius, then continue the point test to determine the shade because of the inequality.

P : Do all three questions have the same form?

DMA-G4 : Both draw two lines.

The subject shows that the concept contained in the source problem is related to the material of a two-variable linear equation system (Figure 4 and DMA-G1). The subject also shows that the concepts contained in the intermediate problem are related to linear inequalities (Figure 5 and DMA-G2). In addition, the subject mentioned that the two problems have the same shape on the graph (DMA-G4). It shows that the subject can mention the concepts contained in the same concept in the source problem and the intermediate problem.

In solving the target problem, the subject states that the solution steps were based on the structure of the intermediate problem-solving steps (DMA-G10 and DMA-G13). However, the target problem solving failed as in the intermediate problem solution because the selection of the

system solution was wrong. It shows that the subject cannot adjust the intermediate problem-solving step to the target problem based on the right analogous relationship.

Mapping Phase

Description of Interview Results

P : Are the three solutions related?

DMA-G6 : The solution to number 1 is only a system of equations so just draw two lines and find the solution points. In number 2, it takes two lines but the lines are vertical and horizontal and are shaded because they are inequalities. In number 3, draw two lines along with shading with a test point (0, 0).

P : Then for the selection of solutions?

DMA-G11: The system solution in number one is at the intersection because the solution is a value that satisfies the two equations. Solution in number 2 is the same because i think the same as number 1, the definition of solution is the same as number 1.

P : Then, is the reason for the solution in number 3 at the point where the two lines intersect the same as before?

DMA-G14: It's the same, nothing else.

Subjects map the two problems the same and had no difference in the choice of solutions in the system graph (Figure 4 and Figure 5). The subject explained that the two only differed in their system graphic images separately (DMA-G6 and DMA-G11). The difference in the problem is that there is shading because it is an inequality, but the solution of the system is the same only in the form of a point which is the point of intersection of the two lines. It shows that the subject failed to determine the exact analog relationship from the source problem to solve the intermediate problem because there was no adjustment in the choice of solutions.

In solving the target problem, the subject solves it with the same thinking from the previous problem, namely the intermediate and source problem without adjustment (DMA-G6 and DMA-G14). It shows that the subject failed to map analog concepts from the intermediate problem to the target problem because previously the subject also failed to map analog concepts from the source problem to the intermediate problem.

Applying Phase

Description of Interview Results

P : How steps in solving number 1?

DMA-G7 : Determine two points, namely the point of intersection of the x and y axes with the method of closing one of the variables, then draw on the Cartesian coordinates, draw a line from the two points, from the two equations two lines are formed that intersect, the point of intersection is the solution.

P : How steps in solving number 2?

DMA-G10: Draw an x-line at a point on the x-axis (vertical line) and a y-line at a point on the y-axis (horizontal line), shading according to the inequality sign, because $x > 3$ then the shaded line to the right is $x = 3$ and $y > 2$ then the shaded above the line $y = 2$.

P : How steps in solving number 3?

DMA-G13: Draw two lines by determining two points first, shading each inequality with a point test so that the shading is above the first inequality, the second is also the same.

The subject solved the intermediate problem with the adjusted steps of solving the source problem by adding shaded areas (DMA-G7 and DMA-G10). However, the choice of solution remains the same only at the point where the two lines intersect. It shows that the subject failed to solve the intermediate problem because he could not determine the appropriate analogous relationship.

In solving the target problem, the subject mentions the completion steps based on the structure of the intermediate problem-solving steps (DMA-G10 and DMA-G13). However, the target problem solving failed as in the intermediate problem solution because the selection of the system solution was wrong. It shows that the subject cannot adjust the intermediate problem-solving step to the target problem based on the right analogous relationship.

Verifying Phase

Description of Interview Results

P : Do the steps in the three numbers appropriate what you mentioned?

DMA-G15: Yes, appropriate.

P : Is it helped when solving number 3 with numbers 1 and 2?

DMA-G16: It helps, draw the line like number 1 and draw the inequality like number 2.

P : Can make questions whose solutions are similar to numbers 1, 2, & 3?

DMA-G17: Yes, just replace the numbers. In numbers 2 and 3, can replace the inequality sign.

The subject has re-checked the suitability of each step mentioned with the results of his work and can also create new problems whose concept is analog even though the analog transfer fails because there is no adjustment (DMA-G15 and DMA-G17). It shows that the subject ensures that the analogy transfer made is correct even though the analogy transfer fails.

In solving the target problem, the subject has re-examined the steps mentioned with the results of his work (DMA-G15). The subject can create a new problem whose solution is the same as the given problem (DMA-G17). The

subject explained that there is a source problem and a problem between only giving the same thought when solving the target problem in drawing the graph, not when choosing the solution (DMA-G16). It shows that the subject still does not understand the solution to the target problem that is compatible with the solution to the source problem and the intermediate problem.

Third Subject Data Analysis

The results of the subject's work on the analogy transfer test are shown in the following figures.

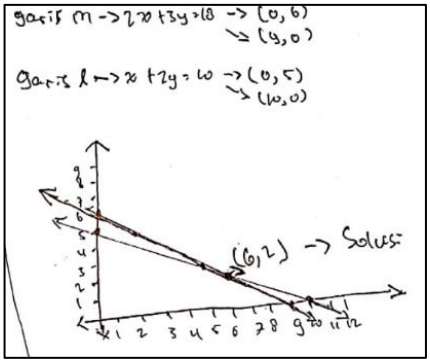

Figure 7. Result of TMA-S Work on Source Problem

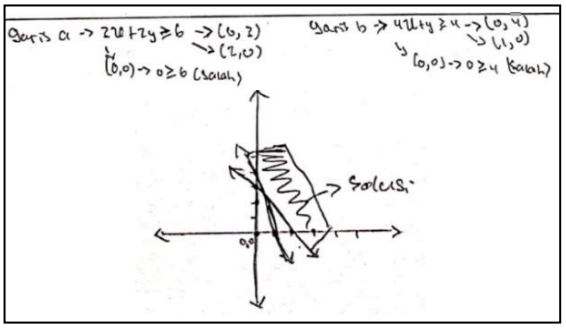

Figure 8. Result of TMA-S Work on Target Problem

Structuring Phase

Description of Interview Results

P : What do you think about solving problem number 1 (source problem)?

TMA-S1 : Draw a line from equations 1 and 2, show the solution.

P : What do you think about solving problem number 2 (target problem)?

TMA-S2 : Same, line drawings and then show the solutions.

P : Do the two questions have the same form?

TMA-S3 : Yes, they were both asked to draw a graph and find a solution.

The subject solved both problems by showing a graphic image of the system and its solution (Figure 7 and Figure 8). The subject shows that the two problems lead to the appointment of a solution from his system (TMA-S1, TMA-S2, and TMA-S3). It shows that the subject can mention the concepts contained and the same concept in both problems.

Mapping Phase

Description of Interview Results

P : The difference between the two solutions?

TMA-S4 : Slightly relate, solution in number 1 is only at 1 point. Meanwhile, solution number 2 is an area that can have many choices of points.

P : Meaning of system solution number 1?

TMA-S6 : The values of x and y that can subtitute into the 2 equations

P : Meaning of system solution number 2? Same or different?

TMA-S8 : Different, number 2 looks like an area. So, the solution could be anywhere. Solutions are the values of x and y that can fit in two inequalities.

Subject can mention the difference in the choice of solutions to the adjusted target problem from the source problem (TMA-S4). The subject explains the solution form of the source and target problem is different but has an analogous concept, namely the value that can meet each element in a system (TMA-S6 and TMA-S8). It shows that the subject can determine the exact analog relationship between the two problems related to the concept of the intersection of two sets and can provide appropriate mathematical arguments.

Applying Phase

Description of Interview Results

P : How step in solving number 1?

TMA-S9 : Drawing two lines with 1 line takes two points, then the solution is found at one point, namely the point of intersection.

P : Why is there an elimination method step in your answer?

TMA-S10 : That's a misunderstanding, at first I don't know where the solution is, that's why there is an intention to find the exact coordinates, but before that, I already know where the solution is..

P : How step in solving number 2?

TMA-S11 : Draw two lines, choose a test point and perform a test point, choose the solution, which is the area above the two lines (meets 2 shades).

The subject can mention the target problem solving steps based on the steps in solving the intermediate problem (TMA-S9 and TMA-S11). The subject also explained that the two have differences in the form of the solution because the solution to the target problem is in the form of shading. The subject initially had difficulty in finding a solution to

the source problem but after looking back at the source and target problem, the subject was able to find a solution to the source problem as well as the target problem because it was related (TMA-S10). It shows that in the implementation phase, the subject has difficulty in finding a solution that can be overcome by looking back at the structure of the two problems. However, the subject can solve the target problem correctly based on the adjustment of the source problem-solving steps.

Verifying Phase

Description of Interview Results

P : Are the steps in number 1 and 2 the same as what you mentioned??

TMA-S12 : Yes, appropriate.

P : Can make questions whose solutions are similar to numbers 1 & 2?

TMA-S13 : Just change the numbers, In number 2, can be replaced with the inequality sign.

The subject has re-examined the steps for solving the two problems that have been mentioned based on the results of their work (TMA-S12). Subjects can create new problems that have analogous concepts with source and target problems (TMA-S13). It shows that the subject can analyze the suitability of the steps and can create other analogous problems.

Fourth Subject Data Analysis

The results of the subject's work on the analogy transfer test are shown in the following figures.

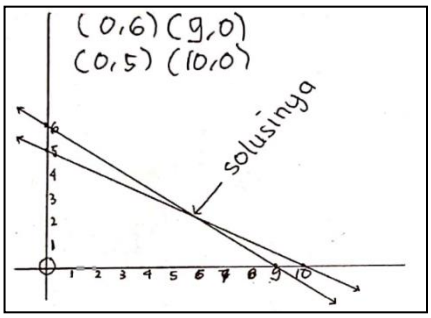

Figure 9. Result of TMA-G Work on Source Problem

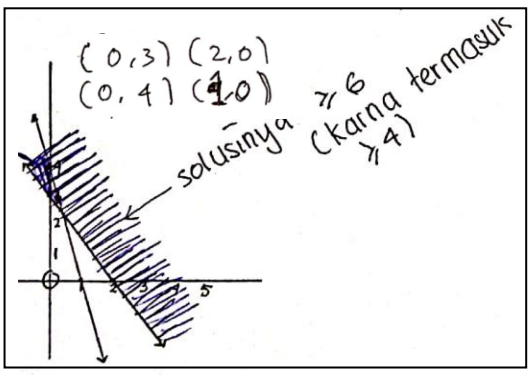

Figure 10. Result of TMA-G Work on Target Problem

Structuring Phase

Description of Interview Results

P : What do you think about solving problem in number 1 (source problem)?

TMA-G1 : Find a set that can substitute in two equations.

P : What do you think in solving problem in number 2 (Target problem)?

TMA-G2 : The solution is the area that is above the two area.

The subject solves the problem by drawing a graph and showing the solutions to both problems (Figure 9 and Figure 10). The subject thinks that solving the two problems ends in finding a solution from the system (TMA-G1 and TMA-G2). It shows that the subject can mention the concepts contained and the same concepts from the two problems, namely related to finding a system solution.

Mapping Phase

Description of Interview Results

P : The difference between the two solutions?

TMA-G4 : In number 1 only finds 1 set of definite solutions. In number 2 is more than 1 set of solutions.

P : So, what is the meaning of the system solution from your understanding in number 1??

TMA-G7 : Numbers that can be used to substitute in all of them (equations 1 and 2).

P : Do you think the meaning of system solution number 2 and number 1 is the same?

TMA-G9 : Different, in number 2 the solution is looking for the greater of the two and the solutions are many. The system solution in number 2 is a variable that can be used to fill in all inequalities. The solution is the one above both inequalities.

The subject mentioned that the solution to the target problem is not one, but there are many solutions (TMA-G4). The subject mentions the definition of source and target problem system solution (TMA-G7 and TMA-G9). Understanding the subject related to the target problem solution is the shaded area of one inequality that has an inequality value that contains both. The subject chooses the shade from an inequality whose value of inequality is 6 because it also contains an inequality with an inequality value of 4 (Figure 10). It shows that the subject has failed in mapping analog concepts from the source problem to the target problem, because in solving the target problem using the concept of inequality on the number line.

Applying Phase

Description of Interview Results

P : How steps in solving number 1?

TMA-G6 : Make a line first and then choose its intersection because it can be used in equations 1 and 2.

P : How steps in solving number 2?

TMA-G8 Draw a line, then look for the bigger one, the choices are ≥ 6 and ≥ 4, choose the shaded one ≥ 6 because it's definitely ≥ 4.

The subject mentions the target problem-solving steps based on the structure of the source problem-solving steps only up to draw the graph (TMA-G6 and TMA-G8). In choosing a solution to the target problem, the subject uses different steps from the source problem. It shows that the subject cannot solve the target problem with an adjusted step from the source problem-solving step because it cannot determine the exact analogous relationship between the two problems..

Verifying Phase

Description of Interview Results

P : Are the steps in number 1 and 2 the same as what you mentioned??

TMA-G10: Yes, appropriate.

P : Can make questions whose solutions are similar to numbers 1 and 2?

TMA-G11: System of equations and inequalities by substituting only numbers.

P : Is it possible to change the sign of inequality??

TMA-G12: Both must be replaced. If less than the smaller number is sought, then the shaded inequality is chosen because the graph becomes smaller (solution area) because there are limits above and below..

The subject has re-examined the steps for solving the source problem and the target problem with the results of his work (TMA-G10). The subject cannot create a problem whose concept is analogous to the target problem because the understanding regarding the solution of the target problem is still wrong (TMA-G11 and TMA-G12). It shows that the subject cannot understand the analogous concept of the two problems and cannot analyze the suitability of the correct steps.

Discussion

Analogy transfer to students with intermediate problems, both successful and failure, the similarities between the two are knowing that all these problems are related. The failure to transfer analogies to students with intermediate problems occurs because students directly use the same steps in the source problem to solve the target problem without adjustment. This is similar to the results of research from Manuaba et al. (2017) which states that the failure of analogy transfer can occur because there is no adaptation phase of the source problem structure to solve the source problem.

Analogy transfer to students without intermediate problems, both successful and failure, the similarities between the two were that they initially could not see the structure of the two problems properly. However, students who succeed in analogy transfer can finally understand the structure of the target problem with the intermediate problem in the application phase. Meanwhile, students who experience analogy transfer failure occur because they finally cannot understand the suitability of the analogy concept of the two problems. The student uses another concept that is different from the source problem when working on the target problem. This is similar to the results of research from Wahyuningtyas (2017) that finds that the factors that influence the transfer of analogies are not knowing that solving the source problem is related to solving the target problem.

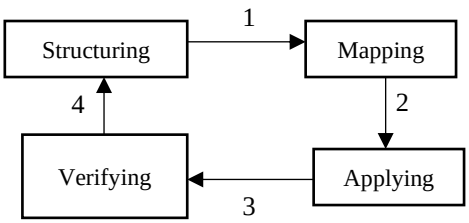

Figure 11. Student Analogy Transfer Success Flowchart with Intermediate Problem

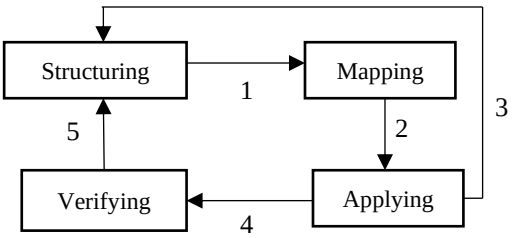

Figure 12. Student Analogy Transfer Success Flowchart without Intermediate Problem

The students' analogy transfers success with intermediate problems and without intermediate problems, it can be seen that the similarities between the two in solving the target problem correctly are using an analogous way to the source problem. Both explained that the system solution definition in the equations and inequality system leads to the same concept, namely the concept of set intersection. Both are looking for elements that become the solution set, which is substitutes each equation in the equations system and inequality in the inequalities system. Therefore, both of them can also understand that the solution to the inequalities system is in the form of a shaded area that has been modified from the selection of solutions to the source problem which is only one point. This is similar to the results of research from Wahyuningtyas (2017) which states that in the analogy there is a similarity

in the concept that lies between the source problem and the target problem.

The difference between the two lies in the phase of applying the transfer analogy (Figures 11 and 12). Students without intermediate problems need to look back at the structuring phase regarding the structure of the two problems to solve both problems with the correct method (Figure 12). This is shown by students initially using the elimination method to find the exact coordinates of the solution of a system of equations. However, after looking back at the similarities in the form of the source problem and the target problem, students can find solutions to the source problem and also the target problem. Based on research from Wahyuningtyas (2017) was found that the influencing factor in the transfer of analogy was when they did not understand the suitability of the source and target problems. This happens because the target problem is still far from the source problem and the subject's limited knowledge. Other research results from Alwyn and Dindyal (2009) which explain the occurrence of analogy errors, one of which is that students do not have a strong understanding of the basic structure of mathematical objects. This is following what happened to students without problems between the initial misunderstanding when they saw the structure of the source problem and the target problem. When the subject looks back at the structure of the two, the subject can find concepts in the choice of solutions as a rationale for the analogy to solve the target problem.

Both have used transfer analogy in solving the target problem based on the source problem. This is similar to the results of research from Kristayulita (2017) and Shadiq (2013) that one performs analogy transfer if one can use previous knowledge to discover new knowledge. In this case, the new knowledge that is formed is to find a solution on the graph of a linear inequalities system of two variables. Other research results from Wardhani (2016) and Kusherawati (2021) concluded that a person is said to have good analogy transfer if he did each phase of analogical reasoning. It shows that students with intermediate problems have performed the transfer of analogies well because each phase in the completion was done well. Meanwhile, students' analogy transfer without intermediate problems is not good because there were few obstacles in the implementation phase. However, in the end, both of them were able to solve the target problem properly. The comparison of the success of students' analogy transfer with and without intermediate problems can be seen in the following table.

Table 5. Analogy Transfer Success Comparison

With Intermediate Problem	**Without Intermediate Problem**
Structuring Phase. - Can mention all of concepts contained in all of problem	**Structuring Phase.** - Can mention all of concepts contained in all of problem
Mapping Phase. - Can determine the right analog relationship and can provide the right mathematical arguments	**Mapping Phase.** - Can determine the right analog relationship and can provide the right mathematical arguments
Applying Phase. - Can solve the target problem based on the source problem solving step	**Applying Phase.** - Has difficulties but resolved by looking back at the structuring phase to solve both problems
Verifying Phase. - Can analyze the suitability of steps and can create other analogous problems.	**Verifying Phase.** - Can analyze the suitability of steps and can create other analogous problems.

Based on research from Mandler and Orlich (1993) which found that the analogy transfer phase occurs more frequently because of the understanding of the schema linkage between the source and target problems. It shows that both of them have experienced the analogy transfer phase because they have seen the relationship between the source problem and the target problem with or without using an intermediate problem (Table 5). The relationship obtained by the two based on schematic mapping is the link in the selection of system solutions based on the analog concept, namely the intersection of two sets.

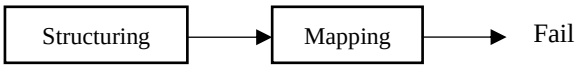

Figure 13. Student Analogy Transfer Success Flowchart with and without Intermediate Problem

The analogy transfer failure in students with and without intermediate problems, the two cannot solve the target problem correctly. Both of them failed in the mapping phase regarding the selection of the target problem solution (Figure 13). Students with intermediate problems understand that the choice of solution to the target problem is the same as the source problem without the need for adjustment so that the solution found in the inequalities system is only one point that lies on two lines. This is similar to the results of research from Manuaba et al. (2017) which states that the failure of analogy transfer can occur because there is no adaptation phase of the source problem structure to solve the source problem. Meanwhile, students without intermediate problems understand that the choice of a solution is based on the concept on the number line,

that is, one inequality is chosen which contains a second inequality because of the sign of the inequality. So, student without intermediate problem choosing the shaded area of one inequality whose inequality sign ≥ 6 because it contains another inequality whose inequality sign ≥ 4. This shows that he does not understand that the solutions to the two problems are related in choosing the solution so he uses another wrong concept, namely the concept of in the number line to determine the solution of a system of linear inequalities on its graph. This is similar to the results of research from Wahyuningtyas (2017) which found that the factor influencing the transfer of analogy is not knowing that solving the source problem is related to solving the target problem.

Table 6. Analogy Transfer Failure Comparison

With Intermediate Problem	Without Intermediate Problem
Structuring Phase. - Can mention all of concepts contained in all of problem	**Structuring Phase.** - Can mention all of concepts contained in all of problem
Mapping Phase. - Unable to determine the exact analog relationship characterized by using the same concept in the source problem in solving the target problem without the need for adjustments.	**Mapping Phase.** - Unable to determine exact analog relationship characterized by using another concept namely number line when solving the target problem.
Applying Phase. - Failed because the previous phase failed	**Applying Phase.** - Failed because the previous phase failed
Verifying Phase. - Failed because the previous phase failed	**Verifying Phase.** - Failed because the previous phase failed

Both experience analogy transfer failure because they cannot transfer existing knowledge into new knowledge in choosing a solution in a system of linear inequalities (Table 6). Both of them failed in the first mapping phase (Table 6). In this phase, the choice of a solution to the target problem should be based on the choice of a source problem solution with the concept of the two sets intersection. The analogy transfer failure with intermediate problems occurred in the mapping phase as much as 85.71% and the rest occurred because they could not solve the source problem. Meanwhile, the analogy transfer failure without intermediate problems occurred in the mapping phase as much as 17.6% and the rest occurred because they could not solve the source problem. It shows that most of the analogy transfer failures occur in the mapping phase if students can solve source problems correctly. This is similar to the results of research from Gede et al. (2016) which found that the failure in analogy transfer was more common in the mapping phase because students can not find the analogous relationship of the source and target problem.

CONCLUSION

Based on the research results obtained, it is concluded that the use of intermediate problems obtains an analogy transfer success rate with a percentage of 39.13% compared to the success rate in the class without intermediate problems of 22.73%. It shows that the intermediate problem can be used to bridge the analogy transfer because it has a greater success rate. Meanwhile, the analogy transfer failure with the largest intermediate problem occurred in the mapping phase as much as 85.71%, and the rest occurred because it could not solve the source problem. Meanwhile, the analogy transfer failure without intermediate problems occurred in the mapping phase as much as 17.6%, and the rest occurred because they could not solve the source problem. It shows that the failure to transfer analogies to students who can solve source problems mostly occurs because of failures in the mapping phase. .

For students who can solve the target problem correctly, the use of intermediate problems results in the transfer of analogies going well in each phase. Meanwhile, the analogy transfer without the problem between there is a bit of a bottleneck in the implementation phase. For students who cannot solve the target problem correctly, the use of intermediate problems fails in the mapping phase by not being able to adapt the source problem-solving structure to the target problem. Meanwhile, in the analogy transfer without intermediate problems, there is a failure in the mapping phase by using other concepts that are wrong and not related to the source problem. This is because the understanding of the shape of the target problem is still far from the source problem.

SUGGESTION

Based on the results of the study which showed that the success rate of analogy transfer with intermediate problems was greater than the class without intermediate problems, the researcher gave suggestions to conduct further research related to the significance of the effect of intermediate problems on the success of solving the target problem..

For teachers who will use analogical reasoning in learning new material, it is necessary to prepare intermediate problems to anticipate student difficulties. Based on the number of failures in the mapping phase,

when teachers use analogies in learning, they can focus on the mapping phase to overcome these failures.

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