Partial Functional Relationship Generalization of Junior High School Students in Solving Pattern Problem

by Eny Suryowati

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Abstract— Generalizing functional relationship is a generalization of covariation relationship and generalization of correspondence relationship. It is called as partial functional relationship generalization because the generalization of covariation and correspondence are done by giving attention to the parts contained in the image partially. In partial covariation relationship generalization, the subject performed relating, searching and extending actions by observing each quantity contained in the picture. Likewise, in partial formal correspondence relationship generalization, subjects obtained the general rules through acts of relating, searching and extending which was carried out by observing the patterns and parts contained in the picture.

Index Terms— functional relationship, generalization, pattern

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1 INTRODUCTION

One of the important activities in learning mathematics is generalization [1], [2], [3]. Several studies on the generalization of functional relationship include research by Carraher et al [4] and Canadas [5]. Carraher's research shows that third grade of elementary school students through learning can produce recursive generalizations and show three ways of generalizing. Canadas's research shows that students in second grade of elementary school through learning can understand functional relationships in terms of doubling (or add to the same number for themselves). Students recontextualizethe problems from real situations into mathematical contexts and otherwise. This research develops one of the problems in Carraher's research to be given to eighth grade students of junior high schools in Indonesia. In this study, we will describe the functional relationship generalization of eighth graders which consist of generalizations of covariation relationship and generalization of correspondence relationship in solving pattern problems. The generalizing process is described based on generalization action and reflection generalization [6].This study describes about partial functional relationship generalization of junior high school students in solving pattern problems. Functional relationship generalization is described by generalizing of covariation relationship and correspondence relationship.
The research questions in this study are namely: (1) how do partial covariation relationship generalization of junior high school students in solving pattern problems ?; (2) how do partial formal correspondence relationship generalization of junior high school students in solving pattern problems ?

2 THEORETICAL FRAMEWORK

A statement about some of the properties or techniques applied to a broader set of mathematical objects, this statement is a mathematical generalization [4]. Generalization can be defined looking for a bigger picture [7]. In other hands, generalization defines the processes by which one drives or induces from particular cases [8]. So generalization is the process of getting a rule that applies to a broader case. In this study, the

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generalizing process uses Ellis's generalized taxonomy theory. Based on the taxonomy of generalization, generalizations are divided into two: generalization action and reflection generalization. Generalization action is divided into three, namely relating, searching and extending [6]. Relating is the process of connecting two objects contained in the problem. Searching is the process of finding the same procedure or pattern from the picture contained in the problem. Extending is the process of applying procedures or patterns obtained in searching for numbers that are not yet known. Reflection generalizationis a statement of student to generalize the form of verbal statements or written statements [6]. Reflection generalization in this research includes the subject's verbal statement during the interview and the subject's written statement on the results of his work. So the generalization in this study is a statement or general rule that students get through the process of relating, searching and extending. Generalization in this study is generalization of functional relationships. Functional relationships are of two types namely covariation relationships and correspondence relationships [9].
Partial functional relationship generalization in this study is a statement about the relationship of covariationand general rules about correspondence relationship obtained partially. So the subject pays attention to the parts of the model that exists in the problem when generalizing functional relationships. Correspondence relationships describe the relationship between two patterns through a general rule, whereas covariation relationships describe the relationship between two patterns that show how quantity in a pattern changes when other quantities also change [9]. The covariation and correspondence relationships can be shown by using tables, words, variables and comparing the representations [10].

3 METHOD

This study used a qualitative approach and was conducted on 8 grade students of junior high school. There are 26 students who work on it and five students work on it partially. One student's work will be described in this study. Students work on the problem pattern in think aloud then interview. Supporting instruments in this study are pattern problems and interview guidelines.

4 RESULT AND DISCUSSION

Here was a question given to the subject: a florist made some model places to put the flower pot (model as in figure 1), flowerpot was marked in a small black sphere. The place was made by leaving a space in the middle of a square. If there

5359

was one square as an empty space then the place could be drawn as in model 1. If there were two squares as empty space then the place could be drawn as in model 2. If there were three squares as empty space then the place could be drawn like model 3, and so on and they were made consistently to meet the flower shop.

1. How was the relationship of adding square to the number of pots?

2. If there was n square, how many pots could be put into?

Figure 1.Place model to put flowers

First question is to show the covariation relationship and second question to show the correspondence relationship.

4.1 Partial Covariation Relationship Generalization
Here is the answer which shows partial covariation relationship generalization.

Task result subject in English

1 empty space   2 empty spaces   3 empty spaces
Then there is 3x4 = 12 then there is 3x6 = 18   then there is 3x8=24
flower pot   flower pot   flower pot

conclusion: 1 = 12 flower pot   1 triangle = 3 flower pot
              2 = 18 flower pot   1 empty space = 4 triangle
triangle
              3 = 24 flower pot   2 empty space = 6 triangle
triangle
                                       3 empty space = 8 triangle

If adding one empty space it will add two triangle or 6 flower pot
Then pattern or 4th model can be concluded three empty spaces = eight triangle
3 + 1 = 8 +2
    4th model → 4 = 10 triangle or 30 flower pot

So the relationship of adding square to the number of pots is if add one empty space then the number of pots will increase by 6 flower pot.

Figure 2.Task result subject (first question)

Based on the results of think aloud and interview with the subject and task result for the subject, the subject read the question and found information about the model of the place to place the flower pot. In relating action, the subject calculated the number of pots and triangles of each known model. The searching action, the subject determined the procedure to calculate the number of pots by multiplying the number of pots in a triangle with the number of triangles in each known model. As seen in the results of the subject's work (figure 2) and interview footage with the first subject, R is a researcher and S is the subject.

R: after drawing this, what do you do earlier?

S: first, I look for ... if there is one empty or square space then there are 12 pots and one empty space there are four triangles and one triangle contains three flower pots, so if there is one first empty space, there are three times four triangles then there are twelve triangles, and if there is one additional space is empty, two triangles will be added, or in other words, six pots will be added.

In extending action, the subject determines the number of pots in the next model (model 4). The subject uses procedural regularities found during searching to determine the relationship of adding square to the number of pots. As seen in

task result (figure 2) and interview footage with the following subject.

R : How do you determine the amount of empty space (square) and many pots in the 4th model?

S : I try by calculating here ... the pattern is 4 ... because one is added in the free space will add two triangles, so for the fourth model, the number of space is empty (square). There is 3 + 1 = 4; the number of triangles will be 8 + 2 = 10 and the flower pot has 10 x 3 = 30
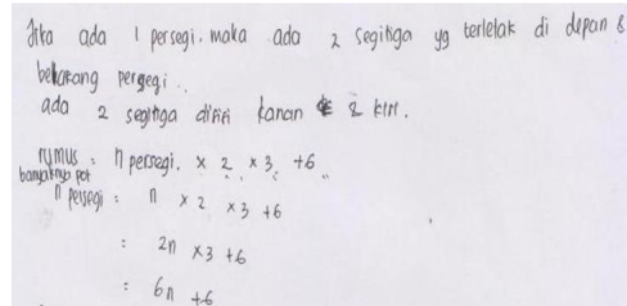
R : So how do you add the square to the number of pots?

S : if the space is empty or square is plus one then automatically the flower pot or triangle is also added by two triangles, in other words there will be six pots.

The subject was in partial covariation relationship generalization done partially. The subject concluded the relationship of adding square to the number of pots by paying attention to each part contained in figure 1. The subject showed that if one quantity was added, the other quantities were also added. The quantity in question is the quantity of empty or square space, quantity of triangles and quantity of pots. Subjects generalized the covariate relationships by using contextual strategies. The subject determined the relationship of adding square to the number of pots based on the parts in the image given.

4.2 Partial Formal Correspondence Relationship Generalization

Here was the answer that showed in generalizing formal partial correspondence relationship.

Figure 3 : Task result subject (second question)

Based on think aloud, interview and task result of the second subject (in Figure 3), in relating action, the subject connected and observed figure 1 partially by calculating the number of squares, triangles and pots of the known model (models 1, 2 and 3). In the searching action, the subject found that from model 1, 2 and 3 (in figure 1) 1 square and 2 triangles were added so that the pot was also added. The number of pots increases six on each model because there are every model add two triangles. One triangle has three flower pots. As shown in the sample interview of researcher with the subject.

R : Could you tell me how you get that formula? (while pointing to the answer to the subject)
S : (the subject draws like model 1) on the first model, each square sides has one triangle so there are four triangle ... this ... the square ... the number ... it is equal to the number of squares ... 2 it is from the front and back sides square ... if there is 1 square then there are two triangles located in front and back so we can multiply 2 ... 3 from the number of 1 triangle there are 3 pots ... so we multiply 3 because there are 2 triangles ... 2 triangles yes … because there are two triangles so we multiply 3 ... 6 from the increase ... each pot is added ... every time it increases square it will add 6 pots.
In extending action, based on the process of searching, the subject found a way to determine the number of pots if there was (n) square that was n multiplied by 2 then multiplied by 3 and added 6 as in figure 3. The number of squares (n) was multiplied by 2 because there are two triangles above and in bottom square. Then it was multiplied by 3 because each triangle had three pots. Then add 6, because there were 3 pots on the right and 3 pots on the left as shown in figure 4. The subject determined the number of pots in the n model based on the parts in the image given.
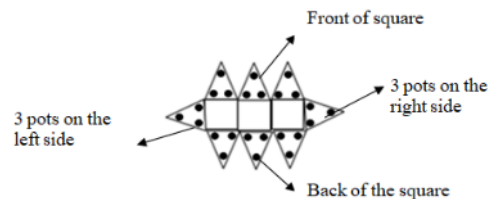

Figure 4. Pot illustrations on the right and left side of the model

5. CONCLUSION

The subject in partial covariation relationship generalization by paying attention to the quantity of each part of the picture. The subject determined the relationship of adding square to the number of pots by observing the number of squares, triangles and pots of the known model. Likewise subject in partial formal correspondence relationship generalization by observing the part of the pattern in the image known to determine the general rule in determining the number of pots if there was (n) square.

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