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Translation of mathematical representation: characteristics of verbal representation unpacking

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ABSTRACT

The translation between mathematical representations was one of the indicators in understanding mathematical concepts. Understanding the things related to the process of student representation translation was very important in learning mathematics. One of the activities that plays a role in translation was unpacking the source. This study aimed to determine the characteristics of student activity in unpacking the source when doing the process of translational verbal representation to the graph. This research was using a qualitative research. The subject of this research were twenty mathematics education students. Selection of research subjects used purposive sampling. The data were collected by test and interview. The results showed that the characteristics of student activity in unpacking the source were two that are drawing scheme of verbal situation and interpreting verbal information with its own language. In addition, there were still many students failed in translation because of difficulties in unpacking the source. The results of this study were expected to add insight into learning to minimize student difficulties in unpacking the source.

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1. INTRODUCTION

Translation between forms of representation is one of the process of representation. According to NCTM, that essentially the process of representation involves translating new problems or ideas, representation processes include translations from diagrams or physical models to symbols or words, and can also be used to analyze and translate verbal problems to make their meaning clearer [1]. Some studies related to the translation of representation and the importance of translation in mathematics learning include [2-9]. Translation is a cognitive process that involves the change from one form of representation to another. Translation is a cognitive process in transforming information in a form of representation to another form [7]. While Ainswort's states that translation is all activity when students are able to understand the relationship between two different forms of representation [10].

The ability of translation between representations is essential for understanding, modeling and solving mathematical problems [11, 12]. Students with high problem solving skills are students who have full ability to do the translation, while students with low problem solving ability is a student who always feel difficult to do translation in problem solving [13]. If the student is able to translate various forms of representation then (s)he has better ability in accessing mathematical idea. In addition, the ability of student translation can be an indicator of the level of students' understanding of mathematical concepts.

Translations involve source and target representation. In translation between representations there are two activities of interpretation and construction [14]. The construction is an activity to generate a new representation (target), whereas interpretation is the activity of understanding representation. There are two types of translation: processing and conversing [15]. Processing is a translation between similar forms of representation. For instance algebraic to other algebraic form which has the same value. Conversing is a translation between two different forms of representation, such as converting a linear equation into a graph form. In this study, the term translations used more referring to conversing is to change the verbal representation into a graph. The results of Bosse's research found four activities in graphal representation translation to symbolic i.e. unpacking the source, preliminary coordination, constructing the target, and determining equivalence [7].

Graph are an important part of mathematics. However, graphing-related understandings are limited [16]. Graph representation is a way of presenting an idea in the form of drawings on the field of Cartesian coordinates. Graph is one of the important mathematical representations for studying mathematical topics such as modeling relationships between quantities, exploring functional characteristics, solving unknown value problems. Graph plays an important role in various disciplines to visualize the verbal situation. For that students should be able to construct the graph based on verbal situations. Many students experience difficulties in translation between different representations including graph, then students are more successful at defining the correct graph among others than constructing the graph [8]. Some research found that translation of verbal representation was the most difficult translation [5, 17-19]. Students are still experiencing difficulties in translation of verbal representation. Verbal representation is defined as a verbal situation or verbal description [17]. The verbal situation is a real-world scenario depicted verbally. While the verbal description is a verbal characterization of symbolic representations, tables or graph.

Based on the results of observations, the conditions in the field also indicate that students experience difficulties in translation of verbal representation caused in unpacking the source. Verbal representation is one representation that has very low information density. This can cause students to have difficulty in unpacking the source. Unpacking the source is a student activity in digging / disclosing the information contained in the source representation. The smoothness of students in unpacking the source will determine the success in translation. Each student unpacking the source is different. It is necessary to understand how the characteristics of unpacking the source. To the knowledge of researchers there has been no research that examines the characteristics of unpacking the source in the translation process.

The aim of this study is to examine the characteristics of unpacking the source in translating verbal representations to graph. The results of this study are expected to add insight in preparing lessons to minimize student difficulties in unpacking the source.

2. RESEARCH METHOD

The aim of this research is to find out the characteristics of students' activity of unpacking the source while interpreting the verbal representation into graph. This study is categorized as a qualitative research. Creswell's proposes that there are five characteristics of qualitative research, there are 1) natural setting, the researcher collects the data in which the research subjects face the problem. 2) Researcher is a key instrument which the main job is to assemble the data either by his own or others' help with documentation or interview. 3) The research must use multiple sources of data both interview, written answer and documentation. 4) Inductive data analysis is included in the research in which the researcher constructs the patterns, characteristics and category inductively. 5) Holistic account in which case researcher creates all-embracing overview from the examined problems [20]. At the same time, Bogdan and Taylor state that a qualitative research is a technique in which descriptive data and observed behavior are explained through the written form [21].

This study was accomplished at Mathematics Education Department. The research subjects were those who had passed calculus 1, subject in which graph function and its attributes were taught. Purposive sampling was implemented into this study in order to obtain the research subjects. These subjects were selected by taking into account the specific criteria based on the needs of the study.

In this study, researcher was the main instrument accomplished by assistance instruments, such as test and interview guidelines. Test instrumen was developed from Celik's research instrument [8]. Meanwhile, Interview guidelines were contained of questions regarding the reason why students chose the steps in completing the test. Then, these two instruments were validated by two experts. The validity results showed that both test and interview guidelines instrument were proper to gather be used.

The process of data collection is done by giving test regarding to translation of verbal representation into graph. While doing the test, students stated what they were thinking about. Then, researcher recorded their voice and observe the manners. The same step was done for many times on other students, so the

answer of each student might be identic. The interview session would also be implemented if the information obtained from the subjects were not adequately accepted. The purpose of interview was to figure out students' opinion about choosing particular step.

3. RESULTS AND DISCUSSION

There were 20 students involved in this study in which the test about interpretation of verbal representation into graph were given to each of them. The result showed that there were two characteristics of unpacking the source done by students in translation verbal representation. First characteristic was carried out by group 1 and second characteristic was undertaken by group 2. In describing the result of this study, the first group was represented by S1 and S2, meanwhile the second groups was drawn by S3 and S4. In translation mathematical verbal representation into graph, all subjects started the first step by reading the case given by researcher. Then, these two different groups were asked to do dissimilar activities. Group 1 did unpacking the source by drawing scheme of verbal situation. Group 2 unpacking the source by paraphrasing verbal information with their own words. Then, they identified important information which were used to construct the graph. After that, these groups did the same activities with different order. The steps of unpacking the source done by group 1 and 2 are explained by Figure 1 and Figure 2 as follows:

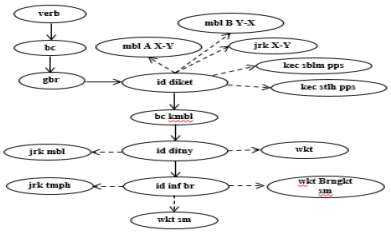

Figure 1. Process of unpacking the verbal representation subject of group 1

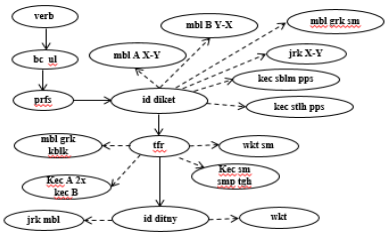

Figure 2. Process of unpacking the verbal representation subject of group 2

In Figures 1 and Figure 2 above, the process of unpacking the source at each stage is shown in the form of codes. The code description can be seen in the following Table 1:

Table 1. The code term in the process of unpacking the verbal representation

Code	Term
Verb	Verbal Representation
Bc	Read the problem
gbr	Drawing the verbal situation
id ket	Identify the things that are known
mbl A X-Y	A car move from X to Y
mbl B Y-X	B car move from Y to X
jrk X-Y	The distance between X and Y
kec sblm pps	The speed of car before crossing is equal
kec stlh pps	After crossing, the speed of A car increase two times from B car and the speed of the B car is permanent
bc kmbl	Re-read the problem
id ditny	identify the things that are asked
jrk mbl	The distance of cars
wkt	Time
prfs	Re-state the information
wkt brngkt sm	The same time
Tfr	Interpret the information
id inf br	Identify the new information
jrk tmph	Mileage
mbl grk sm	The cars move at the same time
wkt sm	Equal time
pps ditngh	The cars cross each other at the middle of the road between X and Y city
wkt pps	Time of crossing the cars
lgkp gb	Complete schema
Mbl grk kblk	The car is moving in the opposite direction
Kec sm smp tgh	The speed of both cars is equal to the middle of the journey
Kec A 2x kec B	The speed of A is twice the speed of B
Bc ul	Read the problem over and over again

Based on the Figure 1 and Figure 2 above, the subjects could unpacked the source (verbal representation) very well. Unpacking the source was the first step in translation the verbal form into graph. Group 1 and 2 unpacked the source with different ways. There were two various characteristics of unpacking the source done by the subjects, namely drawing verbal situation, paraphrasing than interpreting. Although the ways were different, but the subjects unpacked the source successfully. Hence, these activities were helpful to assist students in translation verbal presentation into graph.

Unpacking the source in translation of verbal to graph representation is an activity to assemble verbal information. It is an important activity that can help identify important information used to construct the graph. Bosse's propose that each student must be able to elaborate micro-concept of mathematics in order to acquire broader sistematical knowledge [7]. Furthermore, verbal information is a representation that has a character of low information. The low density of such information is likely to cause difficulties in unpacking. Which may cause any difficulties in understanding the facts. Hence, it is crucial to attain the skill of unpacking verbal representation so as to translation verbal representation into grapics. This idea is also stated by Boose's research that students should be able to work with text configuration and its characters provided by learning sources in order to get well-understanding [17]. Students doing unpacking start from reading the given problem. Reading helps students to understand verbal problems in mathematics [22]. After reading, students do different activities in unpacking.

Unpacking the source is divided into two different characteristics, which are drawing and verbal. Drawing characteristic is represented by subject of group 1. Subject of group 1 performs unpacking the source visually that draw scheme the verbal situation given. Subject group 1 is represented by S1 and S2. Meanwhile verbal characteristic is represented by subject of group 2. Subject of group 2 performs unpacking the source verbally paraphrasing and interpreting verbal information provided with its own language. Subject of group 2 is represented by S3 and S4. The unpacking the source characteristic in translation can be presented in Table 2 below:

Table 2. Characteristics of unpacking the source

Subjects	Characteristics of Unpacking the Verbal Representation	Process of Unpacking the Verbal Representation
S1 & S2	Drawing	When unpacking the source, students draw the scheme of verbal situation
S3 & S4	Verbal	Students unpack the source by paraphrasing and interpreting the verbal information by with their own words.

At the first characteristic, the students draw the scheme to demonstrate verbal situation given by the researcher. Then, they draw the scheme based on the information that have been attained. The pictures show what they get from the verbal information. Dundar's states that the students' success in verbal situations due to able to understand the verbal situation by drawing schema the verbal situation [9]. Verbal situations illustrated through drawing will make it easier for students to record information in verbal situations [23-25]. Further, the information illustrated by pictures/drawing will ease students to identify the meaning. By creating a schematic drawing can make it easier for students to identify existing information. This is in line with the statement of Fennel's that drawing verbal situations can facilitate in unpacking and analyzing relationships between verbal information [26]. In addition, pictures will help them in deciding which strategies are suitable to construct graph. Later, pictures are also able to find new idea and solutions [27].

The second characteristic indicates that the student is unpacking the source verbally. Cawley's states that verbal can be used for stating the problems [28]. In this step, students unpack the source by reclaiming statements through their own words. Krawec's mentioned this as paraphrasing or creating information with different terms but the meaning remains [29]. Then the student interprets the information by reiterating in its own language. Students interpret verbal information to gain the meaning of given information. It is also explained by Leinhardt's that one of the activities in interpretation is paraphrasing [14]. This step is valuable in assisting students to overcome the problems. Students perform interpretation of the source representation of verbal representation. By interpreting information very supportive of problem solving. This is in line with Muir's research that solving problem needs the ability to interpret information [30]. This activity helps students understand information and find strategies to find solutions. With this activity, students have been able to unpack the information of the verbal representation provided smoothly although it is not all explicitly written down.

The characteristics of unpacking the source done by students can be a milestone in arranging learning activity in classroom. So that, the students' difficulty in unpacking the source may be minimized. Still, students will be at ease in translation verbal form into graph.

4. CONCLUSION

This study finds that there are two characteristics of unpacking the source, which are drawing (schema) and verbal (paraphrasing). The findings of this result are expected to be used as learning resource. For the further study, the researcher encourages to conduct research by using another types of interpretation regarding to unpacking the source.

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