Advances in Social Science, Education and Humanities Research, volume 443
International Conference on Science and Education and Technology (ISET 2019)

Mathematical Translation of Verbal Representation to Symbol Representation: A Case Study in Prospective Teachers Having High Mathematical Ability

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Abstract - The purpose of this research is to describe the translational ability of verbal mathematical representation to symbols representation in prospective teachers who have high mathematical ability in solving mathematical problems. One student with high mathematical ability was chosen to be a research participant. Written tests and interviews were conducted to obtain research data. Method triangulation is done by comparing written data and interview data to obtain credible data. Data analysis is performed through data reduction, data presentation, data interpretation and drawing conclusions. The results showed that prospective teachers were only able to unpack the source in the translation stage. It can be concluded that prospective teachers have not been able to translate from verbal representations to symbol representations properly. The results of this research provide input or suggestions for prospective teachers to always develop the translation skills between representations in solving mathematical problems.

Keywords: translation, verbal representation, symbol representation

I. INTRODUCTION

Representation is needed by students to be able to understand mathematical concepts. NCTM (2000) explained that the use of representation can deepen mathematical understanding, so prospective teachers can link between mathematical concepts and communicate their thoughts using representations. Representation is one of the concepts of psychology used in mathematics education to explain some important phenomena about ways of thinking (Janvier, 1987; Meilon, Mariani, & Isnarto, 2019). Kalathil & Sherin (2013) defined that everything made by students to externalize or mathematical ideas about their work is called representation. Hwang, Chen, Dung & Yang (2007) stated that good representational skills are the key to getting the right solution in solving mathematical problems. Representation can be in the form of pictures / tables / graphs (visual), verbal, and symbols (Ainsworth, 2006; Goldin & Stheingold, 2001; Hutagaol, 2013; Hwang, Chen, Dung & Yang, 2007; Neria & Amit, 2004). The ability of mathematical representation is important in understanding mathematics because students face mathematical problems to be solved and when they have to communicate their solutions to others (Hadiastuti & Soedjoko, 2019; Rahmawati, Dwi, Subanji, Erry & Anwar, 2017).

Each mathematical idea can be presented with different representations that are interrelated. Thus, in using mathematical representations to express a mathematical idea, it is possible that prospective teachers must change a form of representation to another form of representation called translation between forms of representation (Gagatsis & Elia, 2004). Translation between forms of representation is the process that occurs in representation. Janvier (1987) explains that the process of translation is the process of changing from one form of representation to another, for example from symbolic form to graphical form. Duval (2006) stated that translational activities from one representation to another are very important in the learning process. Students who do the translation must not only know or recognize the concepts contained in the source by identifying and coding, but can connect the concepts into different forms

according to the intended representation (Bosse, Adu-Gyamfi & Chandler, 2014).

To see the translation between representations in solving mathematical problems, (Bosse Adu-Gyamfi & Chandler, 2014) in his research found there are four stages, namely unpacking the source, preliminary coordination, constructing the target, and determining equivalence. Unpacking the source is the ability to mention the information contained in the representation of the source / problem presented. Preliminary coordination is the ability to determine formulations, strategies to form target representations based on information found in the source representation presented. Constructing the target is the ability to transfer information contained in the representation of the source given into the strategy, the initial step in forming the representation of the target, and forming the targeted representation as a solution to the problem given. While determining equivalence is an activity of checking and concluding the suitability of the results of the representation formed with the given problem.

Research on translational representation is also carried out by Bosse Adu-Gyamfi & Chandler (2014), Firdaus, 2016; Marliyanti, 2016; Molina, Domingo, Canadas, & Castro (2016), Rahmawati, Dwi, Subanji, Erry & Anwar (2017). Research studies conducted by previous researchers are still focused on algebra material. For example, the focus of Molina, Domingo, Canadas, & Castro (2016) research is the translation of symbolic representations and verbal representations on algebra material. The research of Rahmawati, Dwi, Subanji, Erry & Anwar (2017) focuses on verbal translation and visual representation on algebra material. Firdaus's (2016) research on translating between junior high school students 'mathematical representations in solving algebra problems, and Marliyanti's (2016) research on translating between students' mathematical representations in solving algebra problems, especially the material system of linear equations of two variables. Whereas the research of Bosse Adu-Gyamfi & Chandler (2014) focused on the translation of graphs into symbol representation. It was also explained that the ability of students in translating between representations can vary depending on their mathematical abilities.

The research above has not yet elaborated the translation of verbal representations into symbols, and has not considered the mathematical abilities of the research participants. The selection of goal representations is symbol representation by considering the results of research by Neria & Amit (2004) and Nizaruddin, Muhtarom, & Murtianto (2017) who explain that the majority of students often use symbols to solve mathematical problems, compared to using other representations. While the mathematical abilities considered are students who have high mathematical abilities because it is possible to get a translational picture from verbal representation to symbol representation. Based on the description above, the purpose of this research is to describe the translational abilities of verbal mathematical representations to symbols in prospective teachers having high mathematical abilities in solving mathematical problems, specifically the material of the Two Variable Linear Equation System.

II. METHODS

Participants in the research were selected by purposive sampling from prospective teachers of Mathematics Education at the University of PGRI Semarang who have taken Algebra. The initial stage of taking participants is to give a math ability test to 32 prospective teachers. The selection of research participants was based on the results of a mathematics ability test, then prospective teachers who were able to communicate their ideas both verbally and in writing were chosen based on the considerations of the lecturer of the course. Finally, one student who had high mathematical ability was chosen who had good communication skills. After the research participants were selected, a written test was then performed and to obtain data on the ability to translate verbal representations into symbols in solving mathematical problems.

Data retrieval is also done by different methods, namely using interview techniques. Interviews were also conducted to obtain data on the ability to translate verbal representations into symbols in solving mathematical problems. To maintain credibility and dependability, researcher conducted auditing techniques, and triangulated the method by comparing research data from written test results with research data from interview results; the data collection is carried out at different times (Miles & Huberman, 1992; Moleong, 2012). Analysis of research data includes: data reduction, data presentation, and drawing conclusions from the translation of verbal representations to symbols in solving mathematical problems.

III. RESULTS AND DISCUSSION

A. Unpacking the Source

Participants are able to draw up a plan of action that is carried out by identifying information in the problem, so that the participant is able to interpret the problem properly. This is shown from the results of written tests and interviews which show that participants mentioned the information contained in the questions provided, including: a distance of 2 km, a time of 45 minutes, a trip back to the starting point with a time of 22.5 minutes, and assuming x is the athlete's speed and y is the speed

of the current. And what was asked was how much the speed of rowing and the speed of river currents. Figure 1 below is the result of the participant's written test.

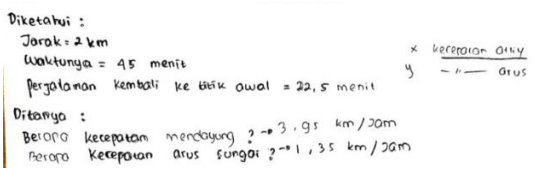

Figure 1. Written Answer related to Unpacking the Source

B. Preliminary Coordination

Participants mention and write the form of the equation obtained from the problem after knowing from the formula of speed that is $v = \frac{s}{t}$, before determining the form of the equation. Participants write the SPLDV equation first, i.e $x - y = \frac{s}{t}$. Then participants determine the equation, i.e. $x - y = \frac{2}{45 \text{ minutes}} \leftrightarrow x - y = \frac{2}{4/3} \leftrightarrow x - y = 2{,}6$ and $x - y = \frac{2}{22{,}5 \text{ menutes}} \leftrightarrow x - y = 5{,}3$. Based on the results of the work it was found that participants have not had the ability to determine formulations, strategies or steps to form a target representation based on information found in the representation of the source presented. Figure 2 below is the participant's written test results.

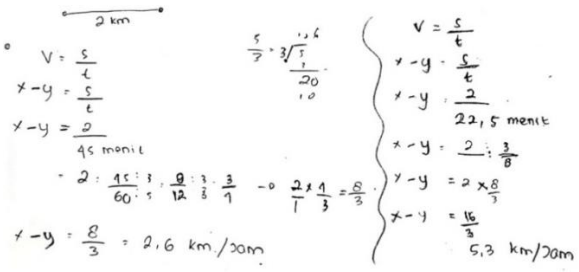

Figure 2. Written Answers related to Preliminary Coordination

C. Constructing the Target

Researcher : How do you solve the problem?
Participant : Looking for speed first with 45 minutes, then obtained speed 2.6 km / hour, the second looking for speed with time 22.5 minutes and obtaining speed 5.3 km / hour, then we made the parable x + y = 2.6 and x - y = 5.3 so we get x = 3.95 it uses the elimination method, then I use the substitution method so that it is obtained y = 1.35.

It can be seen that participants mention and write down answers to find the values of x and y by eliminating the equations x + y = 2.6 and x - y = 5.3, so a value of x - 3.95 is obtained. Substituting the value of x = 3.95 into the equation x + y = 2.6 is obtained the value of y = 1.35. Although it seems that the participants are able to solve the problem, the participants are actually not correct in constructing the initial representation to determine the target representation, and forming the targeted representation as a solution to the problem given. Figure 3 below is the result of the participant's written test.

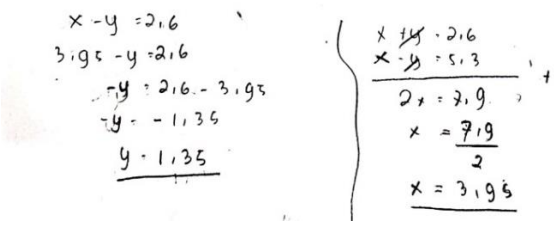

Figure 3. Written Answer related to Constructing the Target

D. Determening Equeivalence

Overall participants seemed to solve the problems given by translating from verbal representation to symbol representation. The steps taken by the participants are digging out information that is known and asked, modeling information by making equations and constructing equations to determine the values of x and y as the target representation. Thus, participants have not been able to carry out the activity of checking and concluding the suitability of the results of the representations formed with the problems given because the results obtained have not been correct and there is no examination of the suitability of the initial representation (verbal) to the target representation (symbol).

Based on data analysis of the results of written tests and interview results, participants have not been able to translate between representations from verbal to symbol because the results obtained are not correct. Conclusion data on the ability to translate between representations from verbal to symbol in solving mathematical problems can be seen in Table 2 below.

Clearly described in Table 2, prospective teachers have not been able to translate from verbal representations to symbols because they are able to determine strategies to form target representations based on information found in the source representation presented. Prospective teachers are only able to do the stages of unpacking the source by mentioning the information contained in the representation of the source or problem presented. The results of this research are certainly inversely related to the conclusions Nizaruddin, Muhtarom, & Murtianto (2017) state that prospective teachers tend to use symbols in solving mathematical problems so that the correct results are obtained. But the research facts show that prospective teachers are unable to translate from verbal to symbol. The possibility of this can be understood because students find it difficult to determine strategies to solve problems. Neria & Amit (2004) explain that when verbal

representations are used many students have difficulty understanding and composing sentences correctly.

Table 2. Participant Skills in Translations between Verbal Representations to Symbols

Translation Representations	Conclusion
Unpacking the Source	Participants are able to mention the information contained in the source / question representation presented.
Preliminary Coordination	Participants have not been able to determine a strategy to form a target representation based on information found in the source representation presented
Constructing the Target	Participants have not been able to transfer the information contained in the representation of the source given into the strategy, compiling the initial steps in forming the target representation.
Determening Equeivalence	Participants have not been able to do the activity of checking and concluding the suitability of the results of the representation formed with the given problem

Duval (2006) has explained that translating between representations not only interacts with the basic concepts contained in the information, but must also be able to connect parts of the basic concepts with different things related to the intended representation. This is in line with the opinion of Bosse, Adu-Gyamfi & Chandler (2014) that someone who does the translation must not only know or recognize the concepts contained in the source by identifying and coding, but can connect the concepts into different forms according to the intended representation. The inability of students to do translation needs to get serious attention from lecturers. Duval (2006) stated that translational activities from one representation to another are very important in the learning process. In carrying out problem solving, a person is required to be able to translate between the representations of the problem well, so that the representation produced in solving the problem is as desired (Janvier, 1987).

IV. CONCLUSION

Based on the discussion of the results of this research it appears that prospective teachers are able to perform the unpacking the source stages, namely mentioning the information contained in the representation of the source/question presented. However, prospective teachers have not been able to carry out the next stage of translation regarding preliminary coordination, constructing the target, and determening equeivalence. Thus it can be concluded that prospective teachers have not been able to translate from verbal representations to symbol representations properly. Furthermore, a similar research needs to be verified by involving a number of prospective teachers so that a comprehensive picture is obtained from the translation of verbal representations into symbols.

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