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Mathematisation of Preservice Teacher in Solving Higher Order Thinking Problem

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***Abstract*— The objective of this paper is to describe the mathematisation of preservice teacher with high mathematics ability in solving higher order thinking problem. Descriptive research with qualitative approach has been conducted with preservice teacher from mathematics department with high mathematics ability as the subject. Data was obtained by giving the higher order thinking problem and interviews. The results of this study point out that the mathematisation of preservice teacher in solving higher order thinking problem are as follows 1) formulate real world problem into the mathematical problem is done by states a bar chart in the form of description, 2) use concepts, facts, procedures and mathematical reasoning to get mathematical solution from mathematical problem is reached by calculate the percentage by using the formula, 3) interpret mathematical solution to the real world problem is conducted by making conclusion from solution, and 4) the last step, evaluate the solution with the context of problem is known by reading again the higher order thinking problem and checking the solution. Mathematisation of preservice teacher is a significant process in solving higher order thinking problem so it is important to develop it.**

Keywords— mathematisation; preservice teacher; higher order thinking problem

I. INTRODUCTION

The ability to solve mathematical problems, especially problems in everyday life requires mathematisation [1, 2, 3, and 4]. Freudenthal [5] states that mathematisation means making things more mathematical. Mathematisations in addition to being the activities of mathematicians also become the activities of learners in understanding the daily situations using a mathematical approach. According to Treffers in Menon [6] mathematisation can divided into two types, namely horizontal mathematisation and vertical mathematisation. Gravemeijer [7] defines horizontal mathematisation as an activity of converting contextual questions into mathematical problems, whereas vertical mathematisation is the activity of formulating math problems into various mathematical solutions using a number of mathematical rules accordingly. Mathematisation in this research is the activity of transforming the problem expressed with the real-life context into a mathematical model or representation, then the completion of a mathematical model or representation is interpreted into a real-life context.

Mathematisation is also one of the seven basic mathematical capabilities needed by an individual to solve mathematical literacy problems [8, 9, and 10]. Mathematical literacy is largely expressed in terms of contextual problems or problems that use real-world contexts because their composition emphasizes the need to develop one's capacity to use mathematics in various contexts.

Mathematisation as part of the process of solving mathematical problems or problems in everyday life makes mathematisation a must-have ability to possess well by learners [11, 12, 13, and 14]. But many learners have difficulty in mathematizing when solving contextual problems [15]. Until now, research on mathematical profiles of prospective teachers in solving mathematical literacy problems based on mathematics and gender skills has not been done by other researchers. The research about mathematisation by Roux [16], Lynch [17], and Winter [18] has not specifically revealed mathematics in solving mathematical literacy problems based on mathematics and gender skills so that this research is relevant to do.

The steps of mathematisation according to Programme for International Student Assessment (PISA) 2012 include formulating, using, interpreting and evaluating. The steps of mathematisation used in this research refer to PISA framework 2012 that is 1) formulate the problem of real world context (contextual problem) into the mathematical problem, 2) using concept, fact, procedure and mathematical reasoning to get mathematical solution from mathematical problem 3)
Interpreting mathematical solutions into real-world contexts at the beginning, and 4) evaluating the problem solution with the real-world context of the problem.

According to the OECD [8], [9], [10] measures mathematical in PISA includes: 1) Formulate, which formulates the situation mathematically, 2) use, which using concepts, facts, procedures and mathematical reasoning, 3)

Interpret, i.e. interpreting and applying mathematical solutions, 4) evaluate, which evaluates mathematical solution. Mathematisation used in this study were 1) to formulate a problem of real-world context into a problem of mathematical, 2) Using the concepts, facts, procedures and mathematical reasoning to obtain mathematical solution of the problem mathematically, 3) Interpreting the mathematical solution to the real-world context to the initial question, 4) Evaluates about solutions to real-world context to the problem.

PISA measures mathematical literacy for around 15 year-old students over the world. In PISA framework, there are six level difficulty of problem. Some researchers say that problem from level four to six also called higher-order thinking problem. As economic and technological changes shape the occupational outlook of today's students, schools have begun to embrace the need to instill "higher order thinking" to prepare the 21st century workforce. Higher-order" thinking means handling a situation that you have not encountered before and is generally recognized as some combination of some characteristics [19]. The objective of this study is to describe the mathematisation of preservice teacher with high mathematics ability in solving higher order thinking problem.

II. METHOD

This research is designed using descriptive research and qualitative approach. A subject of this research is of preservice teacher with high mathematics ability from mathematics education program. The data collection activities in this research used two instruments, namely the main instruments and supporting instruments. The main instruments in this research are the researchers. The supporting instruments in this research are (a) mathematical testing instruments, (b) higher order thinking task instrument, and (c) interview guidelines.

Mathematical testing instruments are a test used to classify the mathematical ability of preservice teachers so research subject with high mathematics ability gotten. Higher order thinking task instrument is a supporting instrument for solving higher order thinking problems. This research uses higher order thinking task instrument 1 and higher order thinking task instrument 2 which are similar and equivalent for triangulation purposes to obtain consistent data. Higher order thinking task instrument is a supporting instrument that is used as a tool to help reveal information in depth about mathematics of preservice teacher with high mathematics ability in solving higher order thinking problem.

The research data collection procedure includes 1) providing higher order thinking task instrument, 2) conducting interviews, and 3) doing triangulation. Data analysis techniques in this research include (1) data analysis of mathematical testing instruments, and 2) higher order thinking task instrument, and 3) interview data analysis which includes data reduction, data presentation, and interpretation and conclusion drawing.
Researchers did interviews on May to July 2017

III. RESULTS AND DISCUSSION

Higher order thinking problem used in this study is as follows.

Fatan is allowed by her mother to take a candy from her bag. He cannot see the candy in the bag. Many candies for each color
are shown in the Figure 1.

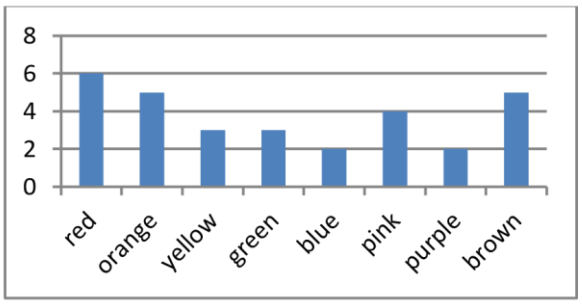

Fig 1. *Many candies for each color*

What percentage of possible Fatan will take the red candy? Explain!

The results of the interview between the researcher (R) and the subject of research (S) based on mathematical steps briefly described as follows.

A. Step formulates a problem of real world context problem into a mathematical problem

R: What information do you get from this problem?
S : Fatan is allowed by her mother to take a candy from her bag. He cannot see the candy in the bag. Many candies for each color are shown in the Figure 1.
R: Is it in there about the important variables that can be used to solve problems?
S: Yes, chart in Figure 1 and percentage of possible Fatan will take the red candy.
R: What do you get from this chart?
S: There are 6 red candies, 5 orange candies, 3 yellow candies, 3 green candies, 2 blue candies, 4 pink candies, 2 purple candies, and 5 brown candies.
R: Why did you choose to use this sign?
S : Because I usually use it.

Based on the interviews above it can be seen that the subject can identify aspects mathematics in the problem and were able to mention the important variables necessary to find a mathematical solution. She made description from bar chart by writing the number each candy according to the colour of candies. Next, she determines the number all candies.

B. Step using concepts, facts, procedures and mathematical reasoning to obtain a mathematical solution of a mathematical problem

R: How strategies do you plan to find a solution?
S: I write the number of candies for each colour, what asked and think about the formula to solve it.

R: How do you apply the facts/rules/algorithms/mathematical structure or strategy when looking for a solution?
S: I write the formula to get the percentage, namely the number of red candies divided by the number of all candies times 100%. The number of red candies is 6 and the number of all candies is 30 so I got 25%.....wait. My answer was wrong; the right answer is 20%.

So the research subject did step using concepts, facts, procedures and mathematical reasoning to obtain a mathematical solution of the problem by writing the formula to get the percentage, namely the number of red candies divided by the number of all candies times 100%. The number of red candies is 6 and the number of all candies is 30. When she solved the problem, she got 25% and in interview, she realizes that the right answer is 20%.

C. Step interpreting mathematical solutions in a real-world context to the initial question

R: Try to explain the relationship between solution that you get and the initial question?
S: At the initial question asked what percentage of possible Fatan will take the red candy.
My answer is 20%. So the possibility Fatan will take the red candy is 20%.
R: Do you think there are other answers to solve this problem?
S: None.

From interviews, the research subject interpret mathematical solutions within the context of the real world in a problem of beginning with the initial questions with solution obtained then making a mathematical solution.

D. Step evaluate about solutions to real-world context to the problem

R: How do you know that the solution you get it right?
S: Because I using the formula to solve it.
R: Are the results/conclusions appropriate to the context you get about?
S: Yes, already appropriate.
R: Try to explain why the results/conclusions you earned is appropriate with the context of the problem?
S: Because I know and write what known, then I solve it using formula that usually I use.

In the last step, evaluate the solutions to real-world context to the problem made the subject of research by reading back about the real world and check solutions.

All mathematical steps carried out by research subject in accordance with the indicator. In a first step, formulating a problem of real world context into the problem mathematically, the subject of research 1) identify aspects of mathematics in terms of the real situation, 2) identify important variables correspond to the real situation, and 3) represents the situation mathematically using appropriate modeling. The second step, using concepts, facts, procedures and mathematical reasoning to obtain a mathematical solution of the problem mathematically, the subject of research 1) devise a strategy to find a mathematical solution, and 2) applying the facts/rules/algorithms/mathematical structures or math strategies when looking for a solution. The third step, interpreting mathematical solutions in a real-world context to the initial question, the research subject interprets mathematical solutions within the context of real life. The fourth step, evaluate about solutions to real-world context to the problem, the subject of research 1) evaluate the suitability of mathematical solutions within the context of real-world problems, and 2) explain the reasons why the results or conclusions mathematically appropriate or not appropriate to the context of the problem. Furthermore, our finding about mathematisation of preservice teacher with high mathematics ability in solving higher order thinking problem seemed in line with the study of Lynch [17]. The research subject also did mathematisation by using concepts, facts, procedures and mathematical reasoning to obtain a mathematical solution [8], [9], [10].

IV. CONCLUSION

Preservice teacher with high mathematics ability in solving higher order thinking problem can reached all mathematisation steps namely formulating a problem of real world context into the problem mathematically, using concepts, facts, procedures and mathematical reasoning to obtain a mathematical solution of the problem mathematically, interpreting mathematical solutions in a real-world context to the initial question, and evaluating solutions to real-world context to the problem. When the research subject solved higher order thinking problem, she got the wrong answer but she didn't know about that. When interviews are conducted, she realized that she get the wrong answer then she correct and make the right answer based on the question. Preservice teacher' mathematisation is an significant process in solving higher order thinking problem. From this study, Preservice teacher with high mathematics ability also has high ability in the mathematisation when she solve the higher order thinking problem.

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