Analizing of field independent and dependent students' understanding in solving statistical problems based on onto-semiotic approach

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Abstract. The purpose of this study is to analyze prospective teachers in problem solving ability using an onto-semiotic approach. The onto-semiotic approach is a method emphasizing mathematical object meaning based on language, concept, procedure, computation, proposition and argument. This research is an explorative qualitative. The subject of research is a mathematic students of STKIP PGRI Tulungagung who have high mathematical ability. The main instrument of the research is the researcher herself, the auxiliary instrument are math problems solving test and interview guidelines. The collecting data techniques are tests and interviews. Data analysis consist of data reduction, display and conclusion. The data are validated by time triangulation. The result of the research shows that, prospective teacher have good categories in the language and the concept in understand the problem, good categories in language, concept, procedures and argument in devise a plan, good categories in terms of language, procedures, computations and arguments in carry out the plan, and bad categories in the look back. So, the onto-semiotic approach can be implemented on learning to improve prospective teachers' understanding in solving math problems.

1. Introduction
One of the goals of mathematics learning is to make students have the ability to solve mathematical problems [1]. For this reason, students who become teacher candidates must be prepared to have good problem solving skills. Unfortunately, there are facts showing that many teaching department students (especially math teacher candidates) have low mathematical problem solving abilities. Observation result showed that when mathematics teacher candidates were asked to solve statistical problems, only 10 people could solve correctly, while others did not solve correctly, and some even wrote nothing.

The mathematics students find it difficult to distinguish symbols and related statistical concepts [2]. As in calculating the average, students show symbol μ, then change to x, but then they do not know what to do. In addition, students are also not able to distinguish symbols of population and samples.

This description shows that the mathematical problem-solving ability is still low and there are disruptions related to mathematical symbols. Problem solving abilities include understanding the problem, planning a solution, implementing a resolution plan and checking the answer [3]. For this reason, the researcher chose to use the onto-semiotic approach to find out the mathematical problem-solving abilities of prospective mathematics teacher students, because the onto-semiotic approach is one approach that concerns in the meaning of each mathematical object.

The meaning of mathematical objects for mathematics education must be emphasized. Underline the close relationship between understanding about meaning and understanding. Theories about the
meaning of mathematical objects have an intrinsic relationship with the anthropological approach to mathematical knowledge (especially ideas from objects and relationships of objects and from the meaning of the use of objects [4].

The onto-semiotic approach is an ontological and semiotic analysis that uses both theoretical constructions of semiotics as mathematical object ontology's, which try to answer the problem of mathematical understanding [5]. The onto-semiotic approach is an ontology of mathematical objects that takes into three aspects of mathematics, i.e. as an activity of problem solving, symbolic language, and a logical and organized conceptual system [6].

According to [3]; the object of mathematics in the onto-semiotic approach includes language, problem situations, concepts, procedures, propositions and arguments, propositions and arguments, while according to [7] mathematical objects in the on-semiotic approach include language, concepts / properties, procedures and arguments. Agreeing with [8] states that the objects of mathematics in the on-semiotic approach are problems, language, actions, definitions and traits, and arguments. The onto-semiotic approach referred to in this study is an expression of mathematical objects that include situations, languages, concepts, procedures, computation, propositions and arguments.

The significance of mathematical problems solving using the onto-semiotic approach is that it can be used to determine the ability of students to solve mathematical problems based on aspects of language, concepts, procedures, computing, propositions and arguments. In addition, [4] stated that the onto-semiotic approach is a tool that explains didactics aimed at effectiveness in the classroom. Furthermore, the onto-semiotic approach can be contribute to instructional design theory that is appropriate in guiding mathematics teaching and learning.

Several studies on the onto-semiotic approach have not focused on problem-solving skills, including [7] who used the onto-semiotic approach to know mathematical representations, and [2] who analyzed design and mathematical problems. Whereas [3] only looked at student profiles based on the onto-semiotic approach. therefore, the aim of this study was to analyze the ability of students to solve mathematical problems using the onto-semiotic approach.

2. Method
This research is a qualitative descriptive. Research subjects were selected using purposive sampling technique. The main instruments are researchers and supporting instruments are tests and interview guidelines. data collected by tests and interviews. The test is used to determine the ability of students to solve mathematical problems based on the onto-semiotic approach, while interview techniques are used to explore and explore the data obtained. To test the validity of the data, time triangulation was used. Data analysis includes reduction, data presentation, and conclusion drawing.

3. Results and Discussions
Based on Polya's statement, the steps of students in solving mathematical problems are understanding the problem, planning a solution, implementing a settlement plan and checking the answers. While the analysis uses the on-semiotic approach which includes aspects of language, concepts, procedures, computing, propositions, and arguments. The following are indicators of problem-solving ability based on the onto-semiotic approach.

| Problem Solving Steps | An onto-semiotic approach Aspects | Category | Description |
|-----------------------|---------------------------------|----------|-------------|
| Understanding problem | Language                        | Good     | Mention terms, images, symbols, which are known completely and correctly |
|                       |                                 | Sufficient | Mention terms, images, symbols, which are known correctly |
|                       |                                 | Less      | Unable to mention terms, images, symbols, which are |
3.1 Understand the problem

Subject in understanding problem can be seen in the following figure.
The subject wrote all the information contained in the question including the known and asked questions. The information that is known is the mean 37 and the largest value is 41. While the question is to make data about shoe size with the average and the biggest value known and classify the data into three criteria, namely large, medium and small. The terms used in understanding the problem are the mean, the biggest value, the data, and the average. The subject mentions the concept used is statistics. Next defines statistics as the science used to analyze data. This definition is not correct. Next, the subject defines the data and provides an example of data. The subject understands all data sourced from the results of the interview, so that it is not correct, and defines the mean and highest values correctly.

In understanding the problem by mentioning all the terms that are in the full problem, the subject defines the term partially as true and gives the sample data correctly. In addition, the subject explained what was asked in the question correctly. Based on the onto-semiotic approach in terms of language, the subject mentions statistical terms in the question completely and correctly. Meanwhile, in terms of the concept aspect, the subject explains the statistical concepts used in the problem by giving definitions of some correct terms and giving examples of data. So in understanding the statistical problem, the aspect of the on-semiotic approach used by the subject is language and concept.

3.2 Devise a plan
The subject revealed that the information in the question was incomplete. To solve the problem, the subject of planning a settlement is by calculating the amount of data, adding up the data and dividing it with a lot of data, and making data using the mean formula. The terms used in this step are still the same in understanding the problem. The concepts used are data and mean. While the procedure for making data by specifying a lot of data is 25. Furthermore, the subject uses the mean formula to make data. The reason for using the mean formula is because it is based on the information known in the problem. While the reason for using a lot of data is 25 that is easier if the data is odd, making it easier to determine the middle value. To determine small and large criteria for data about shoe size, the subject uses the lowest and highest values in the data created. As for the criteria currently using the concept of middle values. To find the middle value of the subject, sort the data first. In this case the concept used is the median and how to determine the median.

3.3 Carry out the plan
Subject’s process in carry out the plan can be seen in the following written answers.
The subject specifies the number of students in one class is 25 people using symbols $n$. The reason for assuming with $n = 25$ is to make it easy to group or search for a middle value, so this is assumed to be an odd number. Next, the subject writes the mean formula using the $x_n$ symbol for each datum. The subject multiplies the amount of data with the mean to get 925. After the subject makes the amount of 925 data. The lowest value of the data created is 36, the highest is 4, and the value that often appears is 36. The whole data created is integer because the subject says that there is no decimal numbers in shoe size. This subject's argument fits with his experience.

In the process of grouping, the subject uses the median or middle value concept. The subject determines the middle value by using the median formula to obtain the 13th number which is 37. Next, the subject determines the smallest value of 36 which is the lowest value of the data created, and determines the highest value of 41 which is the highest value of the data. In this case, the subject can correctly group the smallest, medium and lowest values from the data created using the median concept.

3.4. Look Back
The subject does not take the fourth step, which is look back the answer. Assuming the answer to the settlement is correct. It is also rarely done by the subject in solving other problems. The subject is also not so sure about the answer because the data is made according to the trial and error subject. In addition the subject can make three statements by telling the steps used in solving the problem.

4. Conclusion
The results of the study showed that in understand the problems of prospective teacher students included in the good category. This is viewed from the aspect of language and concepts used, devise of plan of completion strategies, aspects of language, concepts, procedures, and arguments. Carry out the plan includes both categories in terms of language, concepts, procedures, computations, arguments and sufficient in terms of the aspects of the proposition, and checking the answers included in the less category. For this reason, the onto-semiotic approach can be implemented in learning to improve students' understanding in solving mathematical problems.

5. References
[1] National Council of Teachers of Mathematics 2010 Sch. Sci. Math. 47 868
[2] Batanero C, Contreras J M, Diaz C, and Sánchez E 2015 Int Elect J Math Ed. 10 3
[3] Afifah D Septi and N 2016 Proceeding of International Conference on Mathematics, Science And Educations2016 (ICMSE2016) 3 M-110
[4] Juan D G, Carmen B, Vicenç F 2012 ZDM Int. J. Math. Educ. 39 127
[6] Burhanzade H & Aygor N 2014 Procedia-sosial Behav. Sci. 122 477
[7] Font V Godino J D & Gallardo J 2013 Educ. Stud. Math. 82 97
[8] V Font J D Godino and B D Amore 2015 For Learn. Math. 27 2