Beliefs of junior high school teachers on learning process on mathematical problem solving

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Abstract. Teacher’s beliefs had already been categorized by expert in the general process of mathematics learning, but there was still not yet many expert studies on how the teacher beliefs on the learning process of mathematical problem solving. This study was designed to answer the question how the category or orientation of junior high school teachers beliefs on learning about mathematical problem solving. The research approach was a qualitative approach with grounded theory design. Three teachers from three different cluster junior high schools were made as research subjects. Each teacher was given a questionnaire, interviewed, and the learning process that they did on geometry material was recorded and documented for three meetings. The learning process on geometry was chosen because it will contain more mathematical problem solving process. Furthermore, interviews will be noted and coded and synchronized with a questionnaire and analysis of instructional videos by teachers. Based on data analysis, three categories of teacher’s beliefs on the learning process on problem solving had been obtained. The categorization was called good, very good, and excellent category in this research. How the teachers beliefs of each category will be described in detail in this paper.

1. Introduction
Teacher beliefs on learning are very important to be studied, as beliefs will influence how their teaching practices in the classroom. The expert’s study regarding beliefs had experienced an almost exponential growth. These studies include Zoest’s study \cite{1} which had compared the beliefs of four elementary school teachers with a socio-constructivist approach. The result of this study concludes that the belief of teacher with socio-constructivist approach was seen only in the beginning of learning. Whereas in the next section, it appears that teachers have more traditional beliefs in mathematics learning. Furthermore, the Beswick study \cite{2} summarizes three categories of views on teacher beliefs by incorporating the teacher's view of Ernest's mathematical learning \cite{3} and the views on learning in Van Zoest's mathematics (In Beswick) \cite{4}. Table 1 shows the category of teacher's who was presented by beswich.
The table shows that teacher's belief about nature of mathematics consists of three views: **Instrumentalist**, **Platonist**, and **Problem solving**. The **Instrumentalist** view is the view what the teacher assumes that mathematics is a collection of self-contained facts, rules and skills. Furthermore, the **Platonist** view is a view where teacher assumes that mathematics is a collection of facts, rules and skills that are related to each other. Hereinafter, the **problem solving** is that teachers thought that mathematics is a creative science which is useful in everyday life. Then these three views were developed into four views by Mosvold [5]. Table 2 shows development of teacher’s belief categories who was presented by Mosvold.

| Beliefs about the nature of mathematics [3] | Beliefs about mathematics teaching [4] | Beliefs about mathematics Learning [3] | Beliefs about MKT (Mathematical Knowledge For Teaching) |
|-------------------------------------------|----------------------------------------|----------------------------------------|-------------------------------------------------------|
| **Instrumentalist** | Content focused with an emphasis on performance | Skill mastery, passive reception of knowledge | remembering content |
| **Platonist** | Content focused with an emphasis on understanding | Active construction of Understanding | Understanding content |
| **Problem solving** | Learner focused | Autonomous exploration of own interests | Adjusting and differentiating |

Many instruments for knowing teacher’s beliefs have been developed by educational experts. One of research that aims to develop and validate teacher beliefs related to mathematics, beliefs about the nature of mathematics, mathematics teaching, and assessment in mathematics learning was a study conducted by Purnomo [6]. Pubomo develops design of 54 items in which 16 items relate with beliefs about the nature of mathematics, 23 related items for beliefs about mathematics teaching, and 15 items relating to beliefs about judgment in mathematics learning at the first stage for 252 primary school teachers.

All research done by experts has focused on the beliefs of teachers about mathematics in general, not much research that see the beliefs of teachers on the learning process of mathematical problem solving. This has been urgent to be committed because how teacher’s beliefs about mathematical problem solving will influence their teaching practices in the learning process of mathematical problem solving. This statement is corroborated by the research of Beswick [4] who has undertaken research entitled “Teachers ‘Beliefs about Mathematics and Mathematics Schools' Mathematics and Their Relationship to Practice”.
In his research, Beswick stated that teacher beliefs about the nature of mathematics influence their way of teaching the subject (students). Teacher’s Beliefs on problem solving will affect their teaching practices on the learning process of problem solving, indirectly. This research aims to answer the question how to categorize the teachers’ Beliefs on the learning process of mathematical problem solving.

2. Method

Based on the problem in the beginning, subsequently, to obtain the answers used qualitative approach. This research utilized grounded theory designs. According to Creswell [7] grounded theory designs is a systematic qualitative procedure used by researchers to elicit common explanations based on participants’ views, explaining the processes, actions, or interactions between participants. The design of grounded theory designs in this study is the systematic design. Systematic design is widely used in the field of educational research. The design is composed of research that is consistent, detailed, and predictable compared to the initial concept of grounded theory designs. Three Junior High Schools in different cluster (level) in Bandung, Indonesia were chosen as research sites. Cluster is a school group determined based on the school's rank. Based on information from Bandung education office, there are three SMPN cluster in Bandung. The clusters are A, B, and C. The purpose of selecting a school with varying levels is to avoid the reliability and validity issues that may be present in Patton's small sample size [8]. One volunteer teacher in the eighth grade of each school would be created as the subject of observation in the learning process on mathematical problem solving.

Each teacher was given a questionnaire pertaining to how teacher’s beliefs about problem solving teaching, how teacher’s beliefs about problem solving learning and how teacher’s beliefs about what is the positions of mathematical knowledge to learning about mathematical problem solving. The form of some questionnaire statements given to teachers can be seen in table 3. Table 3 shows the shape of some statement of questionnaire. Questionnaire was given with 15 items of statements with a scale of five developed from instruments designed by Howard, Perry, Lindsay, and Van Zoest (in Beswick) [4].

| Table 3. The shape of some statement of questionnaire. |
|-------------------------------------------------------|
| For items 1-3, Mr / Mrs should give a check mark on one item statement in accordance with the learning process undertaken |
| 1 Learning about mathematical problem solving emphasizes how students know the rules and procedures used in the problem |
| 2 Learning about mathematical problem solving emphasizes how students understand the process of solving mathematical problems |
| 3 Learning about mathematical problem solving emphasizes how students construct mathematical problem-solving processes |

After each teacher filled out the provided questionnaire which consisted of 15 statements, each teacher was interviewed about their answers on the questionnaire. The questions could be developed by the researcher according to the needs of the desired data and the teacher's answers at the time of the interview. Furthermore, the learning process conducted by the teachers on the building material was documented to be used as triangulation of data that supports the teacher's statement at the time of the interview. The data obtained from interview were categorized and coded to obtain the category of teacher beliefs in the learning process on mathematical problem solving.

3. Result and discussion

Based on the results of questionnaire analysis, the coding of interview transcripts and analysis of learning videos conducted by the three teachers obtained theory of teacher beliefs to the learning process of problem solving. The category of teacher’s beliefs on learning process on mathematical problem solving can be seen in table 4.
Table 4. Category of teacher’s beliefs on learning process on mathematical problem solving.

| Aspect                                                                 | Good                                                                 | Category Very Good                                                                 | Excellent                                                                 |
|------------------------------------------------------------------------|----------------------------------------------------------------------|----------------------------------------------------------------------------------|-------------------------------------------------------------------------|
| teacher’s beliefs about problem solving learning                        | The teacher considers that learning about mathematical problem solving is emphasized on performance (emphasizing to know rules and procedures without understanding) of the mathematical problem-solving process | The teacher considers that learning about mathematical problem solving is emphasized in understanding the process of solving mathematical problems | The teacher considers that learning about mathematical problem solving is emphasized on how students construct a mathematical problem-solving process |
| teacher’s beliefs about problem solving teaching                        | The teacher considers that if given a mathematical problem then the student completes by receiving knowledge from the teacher | The teacher sees that if given a mathematical problem then the student finishes by constructing his knowledge with the teacher’s direction | The teacher considers that if given a mathematical problem the student completes by exploring the problem-solving strategy based on their own interests |
| teacher’s beliefs about what is the positions of mathematical knowledge to learning about mathematical problem solving | Teacher considers that in the process of solving mathematical problems, solving we must remember the definitions/rules needed to solve the problem | Teacher considers that in the process of solving mathematical problems, we must understand the definitions/rules needed to solve the problem | Teacher considers that in the process of solving mathematical problems, we must be able to adjust and differentiate the definitions used to solve the problem |

The categories in Table 4 are obtained by coding and triangulating from the questionnaire answers, interviews, and analysis of learning videos on mathematical problem solving by the teacher. The following will illustrate one of the aspect of Beliefs teachers on learning about mathematical problem solving, for other aspect were obtained in the same way.

3.1. S-1 teacher (teacher who comes from school one) beliefs about problem solving learning

The beliefs of teachers who are in the excellent category is shown by the S-1 teacher. Teacher S-1 agrees with the statement that learning about mathematical problem solving emphasizes how students construct a mathematical problem-solving process. At the time of the interview the S-1 teacher also revealed that "in the process of problem solving teacher is more inclined to construct, because when students construct themselves it will make it easier for them to communicate what they get. The S-1 teacher also adds his opinion that "If the problem solving that they perform is just to know the rules and procedures and understand it, then they will have difficulty in communicating the answer. The most important capability according to teacher is the ability to communicate. There are students who can answer but he cannot present or explain. In constructing creativity students are required to create and compile something. According to teacher in the construction also has the process of understanding and knowing the rules or procedures, because if students are able to construct automatically students know the rules and procedures and understand the process of solving the problem. This is also seen in the results of the instructional video analysis conducted by the S-1 teacher. As the teacher explains the surface area of the cube, the S-1 teacher chooses an approach by giving the students the opportunity to find their own
surface area using the tools provided. Cube surface area formula was found by students using the concept of square area. In the last part, the teacher giving new problem that has different demands from the previous or example problem. S-1 teacher also gives students the opportunity to work in their own way first and only provides the key words or instructions the student needs.

3.2. S-2 teacher (teacher who comes from school two) beliefs about problem solving learning

Furthermore, based on the results of the questionnaire given to S-2 teachers, S-2 school teachers also agree that learning about mathematical problem solving emphasizes how students construct the mathematical problem-solving process. However, at the time of the interview the S-2 teachers were more likely to disclose that learning on mathematical problem solving was emphasized on how students understood the process of solving mathematical problems. The following was the result from the interview on S-2 teachers about the view.

Interviewer : In the questionnaire statement, why do you agrees that learning about mathematical problem solving emphasizes how students construct a mathematical problem-solving process?

Teachers (S-2) : Why I chose it because in solving a mathematical problem the student has to construct it himself, maybe not one hundred percent. For example a problem solving linear equations of two variables whose form of question is a matter of story. There are 2 (two) children who want to buy stationery, for example Andi bought two books three pencils for a price, the other one bought two books and three pencils at a price so, if there is a third person who buys 10 books and 9 pencils paid? This cannot be solved immediately. They have to make mathematical equations before. Well, here I let them do by themselves. They can make with symbols \( x \) and \( y \) or \( a \) and \( b \). So, given the freedom to the child. To complete it, they can use the way of substitution, elimination and mixture. We give them options, without limiting the way of completion. So the teacher did not interfere a hundred percent. Furthermore, I let what strategies they use to solve the given problem unrestricted, because they already know the basics before, by giving similar questions, but the students can construct their own symbols that they want.

The above interview indicates that the S-2 teacher emphasizes more on understanding the problem-solving process. This is reflected in the expression of the S-2 teacher that "Well, here I let them do by themselves. They can make with symbols \( x \) and \( y \) or \( a \) and \( b \) ". Based on the expression the teacher S-2 only pressed to the construction of symbols, while similar problems have been given before. It is seen in the S-2 teacher's expression that "I let what strategies they use to solve the given problem unrestricted, because they already know the basics before by giving similar problems, but the students can construct their own symbols that they want ".

According to the S-2 teacher above cannot be categorized to the excellent teacher because the construction process intended in the problem-solving process is not by giving similar problems then asking the students to understand the process. The question of problem solving is the question that student does not understand yet. Although S-2 teacher questionnaire agrees with S-1 teacher, the S-2 teacher has different demands to the students during the interview where the S-2 teacher does not see a problem as the construction of the students, because S-2 teacher gives the similar question before giving the problem to be solved by the students. The teacher should have a new problem that has different demands from the previous problem, not a similar question because if it is given it cannot be said as the process of constructing even it cannot be said about problem solving but routine question. Based on these interviews, it can be concluded that the problem-solving process done by the new S-2 teacher at the stage of understanding the presentation given by the teacher and not the process of problem solving that is construction finished by the students.
In learning video conducted by the S-2 teacher, the approach chosen by the S-2 teacher is the same as the S-1 teacher. S-2 teacher chooses an approach by giving students the opportunity to find their own cube nets by using props that have been provided. The formula of the surface area of the cube is also found students using the concept of square area. The difference is that when the problem is given to the student, the S-2 teacher has presented a similar problem before and asks the student to understand the problem, then asks the students to work on a new problem that is not much different from the problem that has been given or presented.

Based on the above analysis S-2 teachers can be categorized into very good category because it has exceeded good category. This is caused the teacher S-2 has demanded an understanding of the problem-solving process such demanding that students can change the symbols not just know the rules and procedures without understanding the problem.

3.3. S-2 teacher (teacher who comes from school three) beliefs about problem solving learning

Furthermore, the S-3 teacher (teacher who comes from school three) in the questionnaire statement agrees with the view that learning about mathematical problem solving emphasizes how students understand the process of solving mathematical problems. This perspective is further observed by interviewing the S-3 teacher. Following the interview footage of the S-3 teacher,

Interviewer  : Why do you think that learning about mathematical problem solving emphasizes how students understand the process of mathematical problems solving?

Teacher (S-3) : For example, there is a material, such SPLDV material, teacher asks students to understand the package book first. Students understand the process that is in the package book. Furthermore, teachers help students to understand by giving simple problems first. Usually students will understand with simple language first. Students are hard to understand the language on the story, not just student difficult to understand sometimes as a teacher also has similar problem. By looking at the student condition at this time, students, even to construct the process of solving mathematical problems and understand the process that has been presented by the teacher, have difficulty.

Based on the results of questionnaires and interviews with S-3 teachers, there were doubts to categorize teachers in the category of very good or good. When it is seen from the questionnaire given by the teacher S-3, it can be categorized as a very good teacher. on the other hand, when interviewed the teacher S-3 shows good indications of teachers who have a view that learning on mathematical problem solving is emphasized on performance (to know the rules and procedures without understanding the problem) towards the process of solving mathematical problems. This is evident from the expression of teacher S-3 that "By looking at the condition of current students, not to construct the process of solving mathematical problems, even to understand the process that has been presented teachers only students have difficulty”. To make sure it is done an analysis of video learning by teacher S-3.

In the video of the learning process conducted by the S-3 teacher on the material for the part finding the surface area and the volume of geometry, the S-3 teacher had presented all the process of how to obtain the surface area formula and the volume of each geometry on the power point. Then the students record the things presented by the teacher. Here was the documentation at the time students record the presentation on the power point. This is form of a student's note from the power point presented by the teacher S-3 can be seen in figure 1.
The S-3 teacher did not construct students to obtain the surface area as the S-1 teacher and S-2 teacher did.

Furthermore, in the process of solving problems related to the material that had been given, teacher S-3 asked students to work on the problems contained in the package book related to the material that had been presented. One form of problem in the textbook the teacher asks the student to finish was “a swimming pool has a length of 40 m and a width of 15 m of water depth at the shallower end of 1.3 m and the deepest end of 2.7 m. How many litters of water volume in the pool?” While the students solve the problem, there were some students who ask about how to solve the problem. Here was a student's dialogue with the teacher during the learning process,

Student : How to solve that, mom?
Teacher (S-3) : If you meet this problem, then the formula used is the trapezoidal area multiplied by the height of the space. The pool will take the shape of a prism space, so the volume formula used is the volume of the prism. The most shallow water depths will be the sides that are parallel to the trapezium and the length of the pool will be high on the trapezium, and the width of the pool will be the height of the prism. So you have to remember what prism volume and what trapezoidal area is the base of the prism.

Based on the teacher's direction, here is the form of student representation on the board. Figure 2 shows one of the results from student's work on the board based on the teacher's direction.

Figure 1. A student's note from teacher's power point.

Figure 2. One of the results from student's work on the board based on the teacher's direction.
In completing these problems, S-3 teacher not only provides formula but also provide opportunities for students to construct the process by describing the problem first. For other categories also obtained to similar way with formula above.

4. Conclusion
Base on analysis results, reveals that the teacher’s beliefs on learning process of mathematics has same way. The way of the teacher’s beliefs on learning process of problem solving also has different categories. From the results of the discussion, it is also obtained the conclusion that confidence or belief of a teacher in viewing the process of learning about mathematical problem solving, also giving impact to their teaching practice about mathematical problem solving in class. For the future research we can see how the impact of teacher’s beliefs in learning problem solving to students’ problem solving ability, gesture of student in problem solving which has been discussed by Harisman [9], and behaviours of student in problem solving.

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