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The Challenges of Junior High School Mathematic Teachers in Implementing the Problem-Based Learning for Improving the Higher-Order Thinking Skills

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Abstract
The study was to describe the challenges of junior high school mathematics teachers in implementing the problem-based learning (PBL) for improving the higher-order thinking skills (HOTS). The study was descriptive explorative research by means of the qualitative approach. The data were gathered by performing interviews and focus group discussions toward nine mathematics teachers in the selected junior high schools that represented four regencies and one city in the Province of Yogyakarta Special Region in Indonesia. Then, the data were analyzed by focusing on the theme in order to attain the proper understanding. The results of the study showed that the teachers' challenges in implementing PBL might be categorized based on the problem sources that came from either the students or the teachers. The challenges from the students were: the students' competencies in one class were various, the students had not been accustomed to working contextual essay test items by performing several steps, lacked self-confidence, struggle, and motivation. On the other hand, the challenges from the teachers were: the teachers lacked understanding of PBL and HOTS, had difficulties in developing the HOTS-based problems, in developing the teaching kits, searching the examples of problem to conduct PBL and test items for measuring HOTS written in *Bahasa Indonesia* and the items regarding HOTS had not been used in the school examination and the national examination.
Keywords: challenges of mathematics teachers, implementing problem based learning, HOTS

Based on the results of a study conducted by Trends in International Mathematics and Science Study (TIMSS) from 1999 until 2001 (Mullis et al., 2000, 2004, 2012) and the Programme for International Student Assessment (PISA) (OECD, 2010, 2014), the achievement of Indonesia students in mathematics is very low in comparison to other countries. The study conducted by TIMSS measured the mathematic cognitive capability consisting of knowing, applying and reasoning. On the other hand, the study conducted by PISA measured the mathematic literacy consisting of the capability of formulating, employing and interpreting the mathematics principles in multiple contexts including the capability of performing mathematic concept and of employing the mathematic concepts, procedures, facts and tools in describing, explaining and measuring multiple phenomena. Basically, both studies have emphasized the mathematic reasoning and the mathematic use of the problem solving activities, which is related to the ability of implementing, analyzing and evaluating the mathematic problems by using appropriate strategies. Brookhart (2010) has named such ability as the higher-order thinking skills (HOTS). Then, developing the higher-order thinking skills will influence the students' critical thinking abilities (Udi & Cheng, 2015).

There are several characteristics of higher-order thinking skills, namely: being non-algorithmic, being complex, generating multiple solutions, involving nuanced judgement, employing mutiple-criterion, involving uncertainty, involving self-regulation in the thinking process, imposing meaning, solving problems effortfully (Resnick, 1992), performing thinking that involves analysis, synthesis and evaluation in the Bloom taxonomy (Liu, 2010; Fischer, 2010) and involving critical and creative thinking (Krulik & Rudnick, 1999). In addition, the higher-order thinking skills also involve analysis, synthesis and creation; in other words, the higher-order thinking skills involve three upper parts of Bloom taxonomy that have been revised (Anderson & Kratwohl, 2001). The activities of higher-order thinking skills with such characteristics might be trained to the students through practice until the students master them.

In order to improve the higher-order thinking skills and the problem-solving capabilities, one of the learning strategies that might be used is the problem-based learning (PBL) (Weissinger, 2004; Arends, 20012). The problem-based learning is a learning approach that focuses on the students and that organizes the curriculum and the learning in unstructured and real-life situations (Mergendoller, Maxwell & Belissimo, 2006; Massa, 2008; Arends & Kilcher, 2010). The problems in the problem-based learning, or also known as PBL, are authentic ones and these problems will be made as the starting points for performing

investigations and discoveries (Arends, 2012) and in collaborating and arranging the students' inter-assignments (Arends & Kilcher, 2010).

According to Arends (2012), the learning syntax by means of problem-based learning will lead the students' orientation toward the problems, will organize the students to study, will guide the individual or the communal (group) investigations, will develop and presenting the problem-solving activities, and will analyze and evaluate the problem-solving process. Similar statement has also been provided by Jonassen (2011); he has stated that problem-based learning includes the problem-focused, the student-centered, the self-directed and the self-reflective activities.

Learning implementation provides multiple benefits for the students. McMahon (2007) performed a teaching by involving the students in attending multiple thinking activities. The results of his study showed that the students' thinking skills improved in terms of their critical and creative thinking skills. In addition, the students who had been given the problem-based learning retained knowledge much longer than those taught by means of traditional teaching, although their learning process might be less than that of traditional students (Udent & Beamout, 2006; Fatade, Mogari, Arigbabu, 2013; Ajai, Imoko, O'kwu, 2013). Similarly, problem-based learning makes the mathematic teaching easier for the students in learning higher and the more applicable concepts (Fatokun & Fatokun, 2013; Udi & Cheng, 2015), positively affects the students' motivation (Etherington, 2011), positively affect the students' academic achievements, positively affect the students' attitudes towards the science course, positively affect the students' conceptual development, keeps the students' misconceptions at the lowest level (Akinolu & Tandogan, 2007) and improves the students' understanding and abilities in using the mathematic concepts in their real life (Padmavathy & Mareesh, 2013).

In Indonesia, the problem-based learning is one of the strategies that has been recommended in the new curriculum that has been implemented since 2013 (Menteri Pendidikan dan Kebudayaan Republik Indonesia, 2013). However, the teachings of higher-order thinking skills have not been implemented well by the mathematics teachers, especially in the Province of Yogyakarta Special Region although higher-order thinking skills are assumed to be beneficial to the students. In order to find the problems properly and to provide the problem-solving alternatives, the problems first should be determined in terms of problem-based learning implementation in order to improve the students' higher-order thinking skills. The study is to describe the challenges of the junior high school mathematics teachers in implementing the problem-based learning for improving the students' higher-order thinking skills.

Method

The study was a descriptive explorative research by means of the qualitative approach. The data regarding the teachers who implemented the problem-based learning for improving the students' higher-order thinking skills were gathered by means of interview and focus group discussion. The data sources were nine mathematic teachers from the selected junior high schools located in four regencies and one city in the Province of Yogyakarta Special Region that had implemented the 2013 Curriculum. The interview was conducted in a semi-structured manner. The materials for the interview and the focus group discussion included the teachers' challenges in implementing the problem-based learning and the efforts of improving the students' higher-order thinking skills in tmathematics teaching within junior high schools. The data analysis was conducted by searching the theme and deciding the inter-theme relationship in order to find the appropriate understanding by using the Bogdan & Biklen model (1982).

Findings

The results of the interview and the focu group discussion were reduced; then, the researchers investigated the inter-theme relationship. Based on the data, the challenges in implementing the problem-based learning in the mathematics in junior high schools might be categorized into two namely the challenges that came from the students and the challenges that came from the teachers.

The Challenges that Came from the Students

According to the teachers, the challenges in implementing the problem-based learning with an orientation toward the higher-order thinking skills (HOTS) would be presented in Table 1.

Based on the data presented in Table 1, multiple challenges were found within the implementation of problem-based learning with an orientation toward the higher-order thinking skills. In general, the teachers exposed positive responses toward the ideas of problem-based learning within the HOTS-oriented mathematic learning. However, they argued that the HOTS-oriented mathematics learning had been relevant only for the students with above-average intelligence level because the learning demanded critical attitude and high motivation, whereas in average junior high school students in the Province of Yogyakarta Special Region were heterogeneous. Some of the students had great performance while the

others had poor performance. As a result, the condition became the main challenge in implementing the problem-based learning toward the HOTS-mathematics learning.

Table 1. The challenges from Students

Results Data Reduction and Data Display	Theme	Inter-Theme Appropriateness
The students in one class were heterogenous	In one class there were the students who were been able to study the materials/to work on the test items because they did not master the materials.	The implementation of problem-based learning that emphasized the HOTS was difficult to conducted because the students had different levels of mastery of the prerequisite materials, the students were not been accustomed to work on the contextual test items, the students were lacked motivation in working on the test items and the students were lacked self-confidence in discovering and in developing mathematics ideas and concepts.
The students' competencies on the prerequisite materials were various.		
The students were not accustomed to working on the developmental test items and the contextual test items.	The students had not been accustomed to working on the contextual test items and, therefore, they had not been accustomed to working on the developmental test items.	
The students were lazy in working on the essay test items.		
The students had difficulties in turning the essay test items into the mathematic models.	The students were not accustomed to working on multiple essay test items.	
The students lacked determination in working on the essay test items.		
The students were lacked motivation to work on the developmental test items.	The students lacked motivation in studying and in working on the HOTS-based test items.	
The students were inconfident in developing/discovering the mathematic concepts.		

In terms of problem-solving activities, the students had difficulties in putting the contextual problems into the mathematic models. The contextual test items were identical to the essay ones that elaborated multiple daily phenomena in the format of mathematic problems. In general, the test items became longer and did not lead directly to the problem-solving formulation. Therefore, when the students encountered such test items they would have difficulties in elaborating the points of the test items and in putting the test items into the mathematic models. Such test items, actually, might have been given more varieties with multiple developments. However, the students were not accustomed to the test items with

more varieties. The reason was that the students were accustomed to being textual according to the teachers' explanation. The students were also not accustomed to developing multiple ideas in the learning process. In addition, the students were accustomed to the simple test items and the simple problems that might be solved by implementing certain mathematical formulas. As a result, when the students encountered the test items that demanded better understanding and critical thinking, they tended to be careless and they were not ready yet to attend the HOTS-based mathematic problems.

The mathematic teaching by means of HOTS-oriented problem-based learning activities demanded the students to be able to master a variety of prerequisite materials well. However, due to the reality that the junior high school students' initial knowledge was heterogeneous, there were challenges encountered by junior high schools in implementing the learning activities. There were students with good performance who could master the prerequisite materials, while at the same time there were other students with poor performance who could not master the prerequisite materials well. For example, when the nine respondents were given the HOTS-based test items regarding the theorem of Pythagoras, they agreed that not all of the students had good capabilities in calculating the results of the square root.

The problems of mastering the prerequisite materials influenced the students' readiness to attend the problem-based learning with an orientation toward the HOTS within the mathematics learning process. The higher-order thinking skills-based learning demanded the students to be able to combine multiple theories in solving the problems. Unfortunately, the facts in the field showed that there were many students who made use of repetition-oriented learning concepts. Oftentimes the students transformed mathematics knowledge from the knowledge that should be implemented into the knowledge that should be memorized. The students were accustomed to memorizing the formulas and practising as many test items as they could. The expectation was that the students would be able to master the problem-solving steps that were given frequently in the tests. However, when the students encountered the test items that demanded the combinations of several or various concepts, they would have difficulties, whereas ideally the students should be able to understand the concept so that they would be able to solve the problems instead of memorizing the problem-solving steps.

The problems exposed in the problem-based learning trained the students to connect multiple concepts. Therefore, the problems had certain level of difficulties. The respondents, namely the nine teachers involved in the study, agreed that the students were not accustomed to mathematics problems with such characteristics. Even several teachers explained the students' condition when they encountered such problems; the students still had difficulties in

putting the daily problems into the mathematical models. The students tended to be less determined and became easily desperate in solving such mathematic problems. The condition was apparent from the students' laziness when they encountered the contextual essay text items. Most of them easily gave up when they had to understand and to interpret the test items into the mathematical model.

The students were not accustomed to understanding the test items using the higher-order thinking skills whereas the test items served as the gates of solutions. The students were demanded to be able to interpret and to understand the purpose of the problems in order to find the solutions. Most of the students physically disturbed when they had problems in the first steps. The real example was apparent when the teachers instructed the students to work on the easier parts when they had a mathematics test in order to keep the good physical condition of the students. Unfortunately, the use of HOTS-based problems involved the contextual problems that were put into sentences and the difficulties in understanding these problems would disturb the students' mental condition; as a result, the students became easily desperate. Based on the phenomena found in the field, the researchers saw that the essay test items became a terrifying thing for the students. That essay test items were difficult had been an impression that developed among the students. The students thought that the essay test items would be difficult from the first time when they saw them were exposed in long sentences. These problems would be a big obstacle for the implementation of mathematic problem-based learning.

The Challenges that Came from the Teachers

The challenges in implementing the problem-based learning with an orientation toward HOTS within the mathematic learning that came from the teachers is presented in Table 2.

The next challenges in implementing the mathematic learning would be presented based on the teachers' point of view. One of the fundamental problems that had been exposed by the teachers was the teachers' insight regarding the problem-based learning and the HOTS. The teachers were still unfamiliar with the problem-based learning, to the higher-order thinking skills, and the relationship between both aspects. The teachers' unfamiliarities with the problem-based learning and the higher-order thinking skills generated negative assumptions of the higher-order thinking skills (HOTS). The developing impression toward the problem-based learning with an orientation toward the HOTS was even complex and difficult. The teachers' difficulties in implementing the problem-based learning process did not result in the different and significant learning results. The teachers were afraid and were inconfident when

they had to guide the students in performing the analysis, synthesis and evaluation. Most of them only taught mathematics only at the level of material implementation.

Table 2. The Challenges from Teachers

Results of Data Reduction and Display	**Theme**	**Inter-Theme Appropriateness**
The teachers had little understanding of the implementation of problem-based learning.	The teachers lacked understanding of the problem-based learning and the higher-order thinking skills (HOTS) and they had difficulties in developing the teaching materials.	The teachers lacked understanding of the implementation of the problem-based learning and the test items for measuring the higher-order thinking skills (HOTS), they had difficulties in developing the learning kits, and they had difficulties in searching the examples of problem-based learning kits and test items written in *Bahasa Indonesia* and the test items that measured the mastery of HOTS.
The teachers had difficulties in developing the problems for training the HOTS.		
The teachers had difficulties in developing the learning kits.		
The teachers had minimum knowledge regarding the concept of HOTS, including the benefits.		
The teachers had difficulties in searching the problem-based learning kits and test items in order to measure the HOTS written in *Bahasa Indonesia*.	The examples of problem-based learning kits and test items written in *bahasa Indonesia* were diffcult to find and the test items that measured the HOTS were rarely used.	
The test items for measuring the HOTS rarely used in the school examination and the national examination.		

Nowadays, the HOTS has not been fully developed in the schools and the condition has been another problem for the implementation of problem-based learning. The under-development of HOTS-based mathematics teaching has been assumed to be caused by the fact that the HOTS-based test items are rarely used in weekly teaching activities. The teachers tend to provide learning materials that might equip the students to do well in the examination. Unfortunately, the students might also complain when they were given such learning materials. The information technology has granted the access toward the test items of the previous or the previous examination. Therefore, they might also complain if they did not find any test item similar to the ones that appeared in the previous year. Even one of the teachers

argued that when they provided the enrichment learning materials the students complained because they found that the enrichment learning materials had not been given in the examination matrix.

The other problem was that the teachers had difficulties in developing problem-based learning lesson plan with an orientation toward the HOTS. The students also had difficulties in connecting the concepts to the daily problems. The reason was that the teachers should be careful in developing the problems so that the students would study the knowledge not only, the understanding and the implementation but also study the analysis, the synthesis, and the evaluation. The problem-based learning activities with such characteristic were not available; as a consequence, the teachers were not able to present varieties of problems to the students.

Nowadays, there are very few examples of explanations and teaching kits for the problem-based learning including the learning assessment for the HOTS, whereas one of the learning models that has been suggested in the implemented curriculum is the problem-based learning and the problem-based learning itself is heavily related to the HOTS. Responding to and solving the concrete problems might be conducted in such a way that improve the students' higher-order thinking skills. In addition, the socialization of Curriculum 2013 has not elaborated clearly the learning process and the teaching kits development by means of the problem-based learning, especially the ones that are oriented toward HOTS. The teachers sense the needs for the instructors in developing the learning process by referring to the desired model and the instructors, for instance, from either universities or government institutions that provide training programs for the teachers.

The mathematics problem-based learning with an orientation toward the HOTS basically might provide flexibility for the teachers in terms of providing various problems, including the open ended ones. However, the students were not confident in delivering their opinions about the problem-solving process. Several teachers argued that most of their students had low self-confidence especially when they found that they had different answers from one to another. They did not realize that within the learning process the teachers assess not only the results but also the process. In relation to this, one of the phases in Curriculum 2013 has been to communicate the learning results. This process might also be made as an assessment time by the teachers. Therefore, when the students were inconfident then the teachers would have difficulties in identifying the students' understanding.

Fundamentally, the problem-based learning process with an orientation toward the HOTS is still relevant to be implemented. Various contextual problems can be distributed under a consequence that the teachers need more time because they should direct the students

to perform the analysis, the synthesis and the evaluation. However, the teachers have limited time allotment for the mathematics teaching process since in Curriculum 2013 there are only five teaching hours while the students have to learn a lot of learning materials. Even under the conventional learning system the teachers sense the time teaching allocation and the teaching material are not been proportional. According to the teachers, five hours a week is not been sufficient for delivering all of the learning materials. Several schools even have added the mathematics teaching periods in order that all of the basic competencies in mathematics can be be distributed. The time allotment was considered as unrealistic for implementing the problem-based learning with an orientation toward the HOTS, which definitely needs longer time.

Another result that the researchers found was that the teachers had difficulties in or had not been accustomed to developing the teaching kits. As a result, they relied on the available worksheets in the market as the reference for composing the mathematic learning materials. The teachers even were not accustomed to developing the students' needs-based worksheets independently. Such a phenomenon caused the teachers to be accustomed to purchasing the worksheets and having difficulties in developing the worksheets independently. Such a consumptive habit caused the independent production of worksheets to be heavy, whereas the ability to produce the worksheets or other teaching kits independently might assist the teachers in formulating the solutions for the students' needs-based learning problems. Then the mathematic problem-based learning with an orientation toward the HOTS is identical to the daily problems and these daily problems might be turned into the essay test items. In relation to the situation, the problem apparent in the field was the fact that the teachers had difficulties in teaching the students to understand the essay test items. In addition, the students' determination was even low when they had to read, to understand, and to interpret the essay test items. All of the nine respondents agreed that the students were lazy when they had to read the essay test items. Most of the students did not have sufficient motivation in solving the mathematic problems by implementing the HOTS. The teachers also had difficulties in motivating the students and in creating the conducive learning atmosphere so that the students would be able to learn mathematics well.

Discussions and Conclusions

The results of the research show that the teachers' challenges in implementing the problem-based learning can be categorized based on the sources, namely the ones that come from the students and the ones that come from the teachers. The challenges that come from

the students are as follows: the students' competencies in one class are heterogeneous, the students have not been accustomed to working on the contextual essay test items by implementing several phases, the students have low self-confidence, the students have low determination and the students have low motivation in working on the essay test items. On the other hand, the challenges that come from the teachers are as follows: the teachers have low understanding of the problem-based learning and the higher-order thinking skills, the teachers have difficulties in developing the HOTS-based learning, the teachers have difficulties in developing the teaching kits, the teachers have difficulties in searching the problem-based learning kits and the test items for measuring the HOTS written in *bahasa Indonesia* and the test items regarding the HOTS are not used both in the school examination and in the national examination.

The teachers' low understanding of the problem-based learning and the higher-order thinking skills can be overcome by holding training programs. The training materials should include the concepts of problem-based learning and those of higher-order thinking skills, the composition of learning sets by using the problem-based learning, the design of learning instruments for measuring the higher-order thinking skills, and the strategies for assessing the higher-order thinking skills. The example of teaching kits for implementing the problem-based learning and the higher-order thinking skills-based test items should also be developed in order to assist the teachers. Within the implementation in the school, the guidance by institutions, for instance the universities or the offices of education, is also necessary so that the teachers will be facilitated in performing their duties and their problems in implementing the problem-based learning will also be overcome immediately.

The students have difficulties in solving the higher-order thinking skills-based problems because they are not accustomed to solving the contextual problems and these problems will various multiple phases in order to be solved. The situation can be overcome by implementing the problem-based learning with an orientation toward the HOTS. In addition, the design of the instrument that will be used for measuring the students' learning achievements should refer to the higher-order thinking skills as well whether the instrument might be used in the daily examination, in the final semester examination, in the school examination and in the national examination. With the learning, the students' higher-order thinking skills, especially in mathematics is expected to be improved.

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