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THE USE OF SCAFFOLDING TO TRAIN STUDENTS' SKILLS IN SOLVING PISA'S PROBLEM (PROGRAMME INTERNATIONALE FOR STUDENT ASSESSMENT) INVOLVING HOTS (HIGHER ORDER THINKING SKILLS)

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Abstract

Curriculum education in Indonesia is K13 which stresses more emphasis on contextual learning. Similar to the one of the purposes of mathematics instructions that students can develop their ability in solving problem, PISA's problem can be used as an option in the process of teaching and learning. According to Wijaya et al (2014) Newman's error analysis is appropriate to identify the errors in solving PISA's problem. Based on interviews with teachers, grade X students of SMAN 1 Taman still have many errorsin solving PISA's problems involving higher order thinking skills. Therefore, we need a strategy to train this ability. This study aims to describe students' errors in solving PISA's problems involving higher order thinking skills, and to describe the scaffolding that could be used to overcome these errors. The use of scaffolding in this study refers to the scaffolding proposed by Anghileri (2006). This research is a descriptive study with a qualitative approach. As subjects of this study were 6(six) students of class X MIA 5 and X MIA 6 of SMAN 1 Taman consisting of 2 (two) students with higher math ability, 2 (two) students with average math ability, and 2 (two) students with lower math ability. A mathematics test and an interview were used as data collection technique in this study. The results of this study indicate that students' errors in solving PISA's problems involving higher order thinking skills involved the followings: (1) comprehension errors; (2) transformation errors; (3) process skills errors; and (4) encoding errors. There are different grades of students' errors in higher group, middle group, and lower group. So, the scaffolding typeswhich were used to overcome the errors of each group are also different. Scaffolding types for the higher group are reviewing and restructuring; while scaffoldings for the average group and the lower group are reviewing, restructuring, explaining, and developing conceptual thinking with different intensity. The intensity of scaffolding given to the middle group is less than those given to the lower group.

Keywords: *Scaffolding, Mathematics, PISA, HOTS,* Newman's error analysis, Senior High School.

INTRODUCTION

According to curriculum 2013, which is better known as 'K-13' in Indonesia, mathematics learning should be in the form of contextual learning.It means that real-world problems should be used as an option in the process of teaching and learning.One of the purposes of mathematics learning according to curriculum 2013 is that students can develop the ability to solve problems. PISA's problems is one of the best options toaccomplish it.

The participation of Indonesia in the Programme for Internationale Student Assessment (PISA) is one of the efforts to find out the condition of Indonesia education program in the world. PISA is carried out every 3 years. Indonesia began joining PISA in the year of 2000. Based on OECD, the results of PISA in 2000 to 2015 in mathematic literacy always ranked at the bottom of the 10th. Even in 2012, Indonesia ranked at 64 from 65 countries. Luckily, for the PISA's results in 2015, Indonesia was ranked 63 out of 70 countries that follow it.In OECD (2015) mentioned that there are three aspects of PISA's problem namely, content, context, and competence. It also explained that PISA's problem consists of 6 levels. The lowest level is level 1 while the highest level is level 6. It can be explained as follows:

Level 6, Students using his thought to solve mathematical problems, making generalizations, formulating and communicating the results of his findings.
Level 5, Students completing a complex situations as well as solving a complicated issue.
Level 4, Students doing effectively with models, selecting and integrating the different representations, then connect it to the real world.

Level 3, Students doing the procedure in resolving problem properly and selecting the best strategy to solve it.
Level 2, Students interpreting problems and solve them with the formula.
Level 1, Students using their knowledge to solve routine problems in the general context.

In a research conducted by Rahmawati (2016) it was uncovered that mathematical ability of junior high school students in resolving PISA's problem were as follows: 33.33% students can solve level 4 and 6, 50% students can solve level 1 and 3, then 66.7% students can solve level 2. As for level 5 no one can solve it. It happens because the students are still not accustomed to solve non routine and complex problems. So, it can be concluded that PISA's problem (especially level 4, 5 and 6) is problem that involves a high level of thinking ability. It is supported by Setyawan (2014) that PISA's problem are divided into two groups, first group is lower order thinking and the second is higher order thinking. Lower order thinking is all about PISA's problem at level 1-3. As for the higher order thinking is all about PISA level 4-6.

Mathematics problems which is categorized as higher order thinkingare reserved for non-routine problems (unknown solution directly). As revealed by Nishitani (2010;11), students who want to complete a mathematics problem that categorized as higher order thinking must have a high motivation and enthusiasm to resolve it because that is given as well as through some process.Students should be able to analyze the meaning of the problem before manipulating the problems into mathematical models to get the correct answer. While higher order thinking skills is a person's ability in solving a complex problem which requires the analysis process prior to manipulate it into mathematical models to get the correct answer.

On the Draft of Mathematics Framework PISA 2015, there are 4 parts of content, namely: change and relationship, space and shape, quantity, and uncertainty and data. However, researcherschoose change and relationshipand quantity because both topics are close to daily activities. There are indicators of PISA's problem in Draft Mathematics Framework PISA 2015, namely communication, mathematising, representation, reasoning and argument, devising strategies for solving problems, using symbolic, formal and technical language and operations, and using mathematical tools.

Wijaya, dkk (2014) mentions that resolving story problem required interaction between real world and mathematics that described with the modeling process. Blum and Leiss (in Wijaya, dkk, 2014) stated that modeling process have seven steps. The steps are similar to PISA's mathematization. According to Wijaya, dkk (2014) indicator of PISA's mathematization as follows: understandingproblem situated in reality, organizing real-word problems according to mathematical concepts and identifying relevant mathematics, transforming real-world problem into mathematical problem which represents the problem situation, solving mathematical problems, and interpreting mathematical solution in terms of real situation.It is represents PISA's indicators.

Based on interviews with teachers, students make errors in solving HOT's problem. According to Satoto (2012), the way that can be used to find out students' errors is to do a study of error analysis. Based on the stage of the mathematization, Wijaya, dkk (2014) identify errors in resolving PISA's problem by using Newman errors analysis, which involve: comprehension, transformation, process skill and encoding. Comprehension Error, student's error in understanding the meaning of all wordson the question so that theycouldn't complete it correctly. Transformation Error, student's error in determining strategies or mathematical concepts that can be used in resolving problem and write it as a symbols or mathematical expressions. Process Skill Error, student's error in completing problems in the form of operating errors, applying the numbers into concept, anddoing unmathematical step. Encoding Error, student's error in completing problems in the form of operating errors, errors in presenting mathematical solutions into real context become a conclusion

According to Wijaya, dkk (2014) "These findings indicate that (Indonesian) students mostly had difficulties in comprehending a context-based task and in transforming it into a mathematical problem."So, students' ability in resolving PISA's problem need serious attention. One of the strategies that can be used is scaffolding.According to Cahyono (2010), scaffolding is an aid given to learners in solving problems. It can be a hint, nudge, warning, outlining problems in the steps to solving, provide examples, and the other actions that allows independent learners.In addition, according to Stone (in Verenikina, 2008), scaffolding is one of teaching strategies that can enhance mathematics learning in building concepts and thinking ability. In contrast to Vygotsky's theory onscaffolding, according to Cao (2014), "scaffolding refers to temporary support provided by the teacher, the more capable peers, or computer tutors to help students solve the problem or carry out a task that they cannot accomplish independently". Based on these statement, Vigotsky revealed that scaffolding can be used by educators to help students to solve problems. Both statements showed that the purpose of giving scaffolding are to build concepts and solve problems. In this study, researchers use Scaffolding to train students in solving problems. Thus, it can be done outside the class.

Anghileri (2006) mentions that students have difficulty in resolving the problem. The existence of such difficulties, student made a mistake. Based on errors made by students, Anghileri provided a scaffolding to help students in overcoming his errors.

According to Anghileri, scaffolding is divided into 3 levels: level 1 (Environmental Provisions), level 2 (Explaining, Reviewing, and Restructuring) and level 3 (Developing and Conceptual Thinking). At level 1, teacher does not interact with their students because in this stage, they just givestudents worksheets that can be done in individually or in a group before doing self-correcting task. For level 2, teachers and students began to engage in direct interaction in the form of explaining, reviewing and restructuring (rebuild understanding). The final level, level 3, consists of making the connection (link), developing representational tools and generating conceptual discourse.

Based on the explanation, in this study, the researchers used scaffolding as stated by Anghileri because it was conducted to train students to solve problems. In this study, researchers used the scaffolding Anghileri level 2 and 3 to train students in resolving the matter of PISA which involve higher order thinking skills because researcherdirectly interacts with the students.

The aims of this study are to answer the following questions, (1) What students' error in resolving PISA'sproblem involving higher order thinking skills?(a) For the higher group, (b) For the middle group, and (c) For the lower group, (2) What kind of scaffolding that is appropriate to cover the student's error in resolving PISA'sproblem involving higher order thinking skills? (a) For the higher group, (b) For the average group, and (c) For the lower group.

METHOD

This study is an exploratory study with qualitative approach that will producedescriptive data in the form of a type of student's errors in solving PISA's problem involving HOTS and the scaffolding that can be used. Stages of this research can be seen in Figure 1.

This research was conducted in SMA Negeri 1 Taman located on Jl. Sawunggaling No.2, Jemundo, Sidoarjo, Jawa Tmur. The study was conducted in the even semester of the academic year 2016-2017. Subjects of this research were students of grade X MIA 5 and X MIA 6.

The data collection in this study were conducted 6 (six) times. The procedure of this research can be illustrated as in Figure 1.

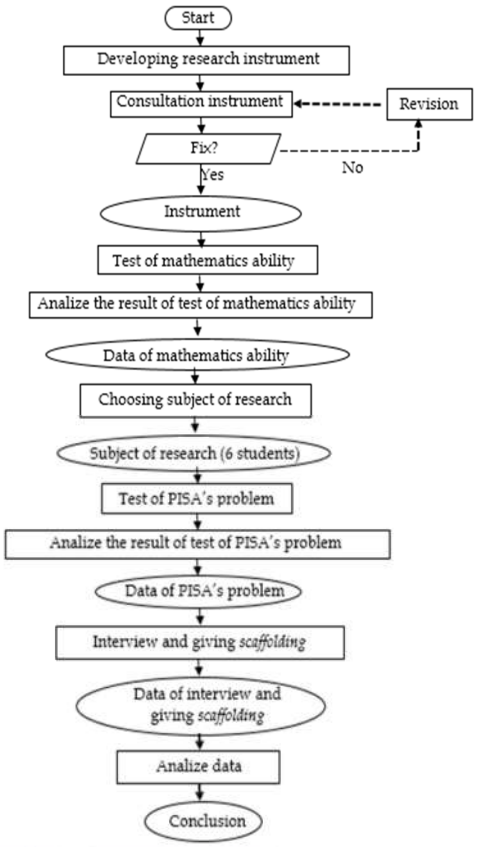

Figure 1. Stages of research

RESULT AND DISCUSSION

1. Error analysis of students in solving PISA's probleminvolving HOTS (Higher Order Thinking Skills)

At the first and second meeting, researcher gives test of mathematical ability that have 3 question HOT's problem to students. Researcher made 3 (three) group that is namely, higher group, average group, and lower group. Every group consist of 2 (two) member. S1 and S2 are include in higher group, S3 and S4 are included in average group, then S5 and S6 are included in lower group. At the third meeting, researcher gives test of PISA's problem to students. There are consist of 3 question, that is 1 (one) question of level 4, 1 (one) question of level 5, and 1 (one) question of level 6. It is adapted in Draft of Mathematics Framework PISA 2015. The result of test of PISA's problem as follows:

			Errors			
			Comprehension	*Transformation*	*Process Skills*	*Encoding*
Subject of research	S1	Question 1		√		√
		Question 2			√	√
		Question 3	√	√	√	√
	S2	Question 1		√	√	√
		Question 2		√		
		Question 3	√		√	√
	S3	Question 1	√	√	√	√
		Question 2	√	√	√	√
		Question 3	√	√	√	√
	S4	Question 1	√	√	√	√
		Question 2	√	√	√	√
		Question 3	√	√	√	√
	S5	Question 1	√	√	√	√
		Question 2	√	√	√	√
		Question 3	√	√	√	√
	S6	Question 1	√	√	√	√
		Question 2	√	√	√	√
		Question 3	√	√	√	√

Based on the table, we know that the higher group made a little errors in every number. Whereas the average group and lower group has the same errors. But, if you check the result of students that is written on the answer sheet you will know the differences of both. The answer of the average group are still using mathematical concepts even thoughthey was not knowing all numbers. The other side, the lower group complete the problems based on logic, taste, andgeneral science such as business view.

2. The use of Scaffolding to train students' ability in resolving PISA's problem involving HOTS (Higher Order Thinking Skills)

Scaffolding gives to students based on their own errors. The use of scaffolding to train students' ability in higher group has a different treatment with another group. There are scaffolding that required by every subject:

No	Errors	*Scaffolding*					
		S1	S2	S3	S4	S5	S6
1	Compehension	-	-	*Reviewing*	*Reviewing*	*Reviewing*	*Explaining*
	Transformation	*Reviewing, Restructuring*	*Reviewing, Restructuring*	*Reviewing*	*Reviewing, Restructuring, Developing conceptual thinking*	*Reviewing, Restructuring, Developing conceptual thinking*	*Reviewing, Restructuring*
	Process skills	-	-	*Reviewing*	*Reviewing, Restructuring*	*Reviewing, Restructuring, Developing conceptual thinking*	*Reviewing, Restructuring, Developing conceptual thinking, Explaining*
	Encoding	*Reviewing*	*Restructuring*	*Restructuring*	*Reviewing, Explaining*	*Reviewing, Restructuring*	*Reviewing, Explaining*
2	Comprehension	-	-	*Reviewing*	*Reviewing*	*Reviewing, Restructuring, Explaining*	*Reviewing*
	Transformation	-	*Reviewing*	*Reviewing, Restructuring*	*Reviewing, Explaining, Restructuring*	*Reviewing*	*Reviewing, Restructuring, Explaining*
	Process skills	*Reviewing*	-	-	*Reviewing*	*Restructuring, Developing conceptual thinking*	*Reviewing, Restructuring*
	Encoding	-	-	*Reviewing*	*Reviewing*	*Reviewing*	*Restructuring*
3	Comprehension	*Reviewing*	*Reviewing*	*Reviewing*	*Reviewing, Restructuring*	*Reviewing, Restructuring*	*Reviewing*
	Transformation	*Reviewing, Restructuring*	-	*Reviewing, Restructuring*	*Reviewing, Restructuring, Developing conceptual thinking*	*Reviewing, Restructuring, Explaining*	*Reviewing, Restructuring, Developing conceptual standing, Explaining*
	Process skills	-	*Reviewing, Restructuring*	*Restructuring*	*Reviewing*	*Restructuring*	*Reviewing*
	Encoding	-	-	*Restructuring*	-	*Reviewing, Explaining*	*Reviewing*

Based on the table, we know that the higher group need a little scaffolding. They just need a reviewing and restructuring for all errors. Even they didn't need a scaffolding. They know how to overcome their errors by themself. For average group, they have same scaffolding with lower group. But if we check for every number and every errors, we will know the differences of average group and lower group. For instance, the use of scaffolding that is needed to solve comprehension errors on question number 2. The average group needed reviewing, while the lower group needed reviewing and restructuring. Another example is the use of scaffolding that is needed to solve process skills errors on question number 2. The average group needed reviewing, while the lower group needed reviewing, restructuring, and developing concept thinking.

CONCLUSION

Based on the data of analysis, it can beconcluded that:

1. Error analysis of students in solving PISA's problem involving HOTS (Higher Order Thinking Skills)
   a. The errors of higher group are comprehension, transformation, process skill, and encoding. Higher group doesn't doing all errors in every number.
   b. The errors of average group are comprehension, transformation, process skill, and encoding. Average group doing all errors in every number. But, they are showing the steps in spite of incomplete. Average group knowing some concept that used to solve PISA's problem even though it is not clear.
   c. The errors of lower group are comprehension, transformation, process skill, and encoding. Lower group doing all errors in every number. They didn't connected real-world problem and mathematics.They solve PISA's problems based on logic, taste, and general science such as business view.

2. The use of Scaffolding to train students' ability in resolving PISA's problem involving HOTS (Higher Order Thinking Skills)
   a. The use of scaffolding for higher group are reviewing and restructuring.
   b. The use of scaffolding for average group are reviewing, restructuring, explaining, and developing concept thinking. Even they didn't need a scaffolding. Sometimes, they know how to overcome their errors by themself.
   c. The use of scaffolding for lower group are reviewing, restructuring, explaining, and developing concept thinking. The intensity of giving scaffolding on every errors in every number more than average group.

SUGGESTION

Based on the results of this study, we suggest the following:

1. There is a need to conduct further research for using scaffolding to train students' skills in solving PISA's problems (Programme Internationale for Student Assessment) involving HOTS (Higher Order Thinking Skills) as the follow up and extension of this research. Besides, the researchers should be more focus to analyze how to give scaffolding for each student.
2. It is important to give more consideration in choosing the time of research, so that students would be more interested tosolve the problem, to be interviewed and be given scaffolding, because when students are not interested in doing so, they would not be a maximum result.

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