ROLE OF PHYSICS' QUESTIONS ON THE IMPROVEMENT OF THINKING SKILLS: A CASE OF INDONESIAN STUDENT

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Abstract

Several studies analysing teacher's questions and their categories have been reported; however physics questions is very important in a science class. This study focuses on the physics questions and their roles especially in student thinking skills. We described the implementation results of learning by questioning (LBQ) in the physics classroom in Indonesia. We also assessed teacher and students response after a learning process. The research design used Research and Development (R & D). The number of students involved in the research are 124 students, composed of 45 boys (36%) and 79 girls (64%). The research obtained findings: (a) the implementation of LBQ can improve students thinking skills with the acquisition of gain attributes the increasing to the ^{10th} thinking skills that are in the range of .27 to .73 with an average of .48, (b) eight from ten attributes (80%) are consistent and can be improved by LBQ. There skills are analyzing and synthesizing, raises questions, information searching, utilizes concept, makes inferences, generates implications, decision making, and creative problem solving, (c) the teacher models and the students responded positively to the LBQ. Teacher models assessing 95% that LBQ appropriate application of learning to be applied, while the students gave a positive response of 76.7% .

Keywords : *physics' questions, LBQ , thinking skills*

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1. Introduction

Physics teachers often advocated problem solving but rarely think about the importance of creating the problems and asking questions. Educators only give a problem to learners but they don’t orient student to the problem. Often problems arise from teachers because of the failure or the lack of skilled during the creating of problem. In fact, one of the important part of constructivism is construction of questions. In addition, when the students try to answer questions or solve problems, they also motivated to create questions. According to Piaget (Slavin, 1997), the formulation of questions is one of the most important parts of the most creative and ignored science in science education. The kind of teachers questions and the way in which they are asked can, to a large extent, influence the nature of students’ thinking as they engage in the process of constructing scientific knowledge (Chin, 2007).

Questioning is not an easy skill for educators in learning. Not surprisingly sprung various techniques or how to ask which is integrated in the learning begin learning simply opening up a whole presented along the stages of learning. From a series of learning through questioning techniques, in this study focused on two types of learning through questioning. It is based on the experience of previous study which have done. The first was learning through a series of guiding questions and the second was Socratic Method. Questions were used to develop the topics by not only generating discussion but also to guide the discussions. Teacher while encouraging and responding to students’ ideas, exercised subtle control in deciding which lines of thought need to be pursued and how elaborately so that the discussion/lesson remained on track in spite of digressions (Kawalkar & Vijapurkar, 2011).

The preliminary research findings stated learning through a series of guiding questions can improve students' understanding of modern physics topics. Classroom action research conducted on students' MA Acceleration in Mojokerto East Java, Indonesia improved students’ understanding of physics concepts with the acquisition of gain (g) is higher than each cycle. The findings of both studies demonstrated the application of the guiding question also improve the performance of students in laboratory activities and improve the understanding of physics concepts that students achieve. Giving a series of guiding questions to help students in the laboratory opened a preliminary understanding as an introduction to the laboratory activity. The ability of students dug through responses submitted answers. Answer correctly used as stock are still held in the theory and new findings. The wrong answers are expected as cognitive conflict that makes the experience so valuable student at a time physics misconceptions will not happen again. Experience of truth and error concepts become meaningful in the long-term memory of learners. This is the essence of constructivist learning theory.

Other study has also been done at the level of college in the course of history of physics. The result is learning to apply the Socratic Method done to make students and faculty enthusiastically. Implementation of student-centered learning and the presence of activity in learning. The results of the assessment of students' critical thinking showed more than 60 % of students answer leads to thoughts of Socrates (Suprapto & Dwikoranto, 2010). Based on the findings of the research that has been done can be made a conclusion that learning by questioning (guiding question and the Socratic method) improve the understanding of physics concepts, laboratory performance, and enable the learners .

The results of these studies map the thinking skills of students in senior high school and bachelor student for learning physics. However, according to Piaget's theory of cognitive development (Slavin, 1997), actually thinking skills can already be seen since the child is at the stage of formal operations (in junior high school), although less pronounced. Operating characteristics such formal reasoning, deductive reasoning, abstract thinking, problem solving, and making generalizations. Most of the new high school students can achieve these characteristics. For the current study focused on high school students' thinking skills are more observable and measureable. So, that makes it easier to be optimized at the college level.

Meanwhile other types of learning that has been asked by Corebima developed since 1985 is patterned “PBMP (*Pemberdayaan Berpikir Melalui Pertanyaan*) or known as Thinking Empowerment by Questioning (TEQ) (Corebima, 2010). The author’ analysis showed a similarity learning patterns between TEQ and the Socratic method and the guiding question. The orientation of all types of learning are asked to make learners active, creative, and thinker.

Despite the similarity of the patterns of learning TEQ with the Socratic method and the guiding question but in each learning model has a different emphasis and excess. In the application of the learning model with the Socratic method and the guiding question is more emphasis on the quality of the learning process that takes place that prioritizes communication patterns with discussion raises the question between teachers and students and also between students with students. While the learning model TEQ to raise questions of the students made more structured by using the student worksheet, this resulted in questions that arise from the students tend to be focused and well-documented but less flexible in the learning process.

Based on that foundation, the researchers intend to combine the learning by questioning in a learning package. The hope findings in the field such as the failure of the orientation problem (which is essentially a question orientation) to the learners because of low teacher questioning skills can be reduced.

On the other hand, the empirical data from the National High School Exam for the last 3 years (2008-2010) in western Indonesia (including East Java) showed although the average value of physics achievements were high but the results of the mapping over indicator of learning outcome showed the reasoning and thinking skills of high school students still low. This is due to lack of the competent teachers in developing assessment based on higher order thinking (C4 to C6 in cognitive level), teachers are only competent to the level of C3. Consequently, thinking skills of students is still low (Basuki, et al., 2011).

On the other side of human nature (including learners) are thinkers. In every life learners will think of something. Armed with a process to think (minds-on) someone will be able to make sense of something. A series of questions will help learner is expected to do though think in class. Even learning will be more meaningful if the learning activities provide " minds-on/hands-on activities" (Carin , 1993).

Referring to the constructivism learning paradigm, it is important to do this research. The essence of constructivism in learning is the construction of the questions. In addition, for the students who try to answer questions or solve problems, they are also expected to be motivated to create questions. Experience while guiding researchers and students of physics microteaching and observations of teaching practice program directly in school, especially high school, many teachers / prospective teachers who are good at giving problems and lack the skills to quest. There is the fact many teachers / prospective teachers who directly wrote " formulation of the problem : .... " on the board or in a slideshow during a lesson. Predicate that "teacher is not a reliable oriented problem but just giving problem to students" seem to be a problem in learning physics.

In fact, problem should arise from the minds of the students as the product of the orientation problem by giving a series of questions from the teacher. According to Elder & Paul (2007), the actual questions will never stop something in life and learning. Constructions in question is not easy to implement the learning, however, requires learning by design, it will be developed for a model of learning by questioning in this study.

Rationally, the purpose of this study is doing test of learning materials have been developed piloted on a limited basis, and then performed: identification of competencies (attributes) students' thinking skills that can be improved by applying LBQ in Physics learning, LBQ delineate potential in improving of thinking skills of students, description of the response from teachers' model and the students in implementing learning through LBQ.

2. Research Method

Preferred type of research is the Research and Development (R & D). The study was begun by producing certain products and testing the effectiveness of these products. Then, performed product of learning materials was obtained ready to be implemented. Implementation of the learning materials is done in senior high school student in East Java- Indonesia, as the target schools and allows a team of researchers (adaptable) learning materials in a limited scale trials. The number of students involved in the research are 124 students, composed of 45 boys (36%) and 79 girls (64%).

The study is limited to the 10 attributes of thinking skills (Elder & Paul, 2007). Implementation of lesson plan in high school that allows the implementation of learning appropriate to the topic / research material to be studied. The instrument used in this study consisted of: Instrument identification attributes thinking skills, thinking skills test, and questionnaire responses for teachers' model and students in learning process. The data collected from these sources validator, learning observer, teachers, and students can basically be classified into types of data attributes (good/ moderate/ poor , valid/ invalid , positive/ negative) that described in a sentence statements and research outcomes. Some attributes are quantified for easy analysis. So the data analysis technique used is the percentage of descriptive statistical analysis and logical analysis. Descriptive statistics were used to describe the process and display the data in a more meaningful and easier to understand, for example in the form of a table.

Improved thinking skills students calculated by the normalisation gain formula (g) (Hake, 1998; 1999; Savinainen & Scott, 2002):

$$g = \frac{S_{post} - S_{pre}}{100\% - S_{pre}}$$

S_{post} and S_{pre} is the average score thinking skills of the final and the previous cycle are expressed in percent. The magnitude of g <gain factor> are categorized as follows :

$g > 0.7$ = high

$0.3 \leq g \leq 0.7$ = moderate

$g < 0.3$ = low

3. Result and Discussion

This research study has been produced the examples of learning materials through question (Learning by Questioning) which consists of two high school physics topics: the static fluid in accordance with the Education Unit Level Curriculum 2006 and Newton Laws according to the curriculum in 2013. The learning materials consist of syllabi, lesson plans, student worksheets and guidelines, student books, LBQ assessment sheets and key. Developed a learning material has met the construction and validation of the contents of each component as described in the study on the results of the research.

The result of the acquisition of thinking skills of students consisting of 10 main attributes are presented in Table 1 below.

Table 1. Gain acquisition of student thinking skills

Considering the implementation results of LBQ's materials, the role of learning thinking skills upgrading asked to indicate the acquisition gain attribute the increase to 10 thinking skills were in the range of .27 to .73 with an average of .48 (moderate). The highest achievement attained by students in terms of information searching and lowest in making assumptions. In other words, there are eight attributes thinking skills (80%) of the ten studied are consistent and can be improved by LBQ. The eight attributes are analyzing and synthesizing, raises questions, information searching, Utilizes concept, makes inferences, generates implications, decision making, and creative problem solving. Through study asked students skills in terms of improving the quality of the question (raises questions) increased by 72 percent. Learning by providing students an active bridge question answer questions that spur the emergence of new questions. This appears to correlate with the development of students' reasoning. This is in line with the statement Zubaidah et al. (2001), through the questions can be developed critical thinking skills, which is one of the characteristics of the development of formal reasoning.

Actually, the question that triggered the students to hone their skills to think there are 3 questions that literal, inferential questions and inquiries metacognitive (Fusco, 2012). In this study newly developed on a literal and inferential level, while the level of metacognitive training is merely the beginning. Literal questions are questions that are often called "closed -ended " or used for final questions and cover because this question requires an answer correct. Questions that contain facts and events that actually exist. Question literal reference to the facts that exist and need concrete examples. The answer there is literally only one answer .

In contrast, inferential questions or questions of interpretation can have many answers and usually students often suspect, draw conclusions and relate it to the reference. Inferential questions referred to the "open -ended " because it is not just one answer from the students because they have a variety of reasons. With inferential questions students will be trained to develop other questions from a question that has been given by the teacher. Inferential questions require answers that require guidance related. Usually this question should be more careful to answer because it could be more than one correct answer. At the time of reading, to answer inferential questions can not be found in the book, but it is supported by the facts in the book. To answer inferential questions supported with the question of why and how. Therefore the question -based learning strategies very well when applied in learning activities and is used to hone students' thinking skills, especially in the inferential questions. As for the literal questions students sharpen memory .

The next question is a metacognitive level. Teachers should plan question with metacognitive level, which encourages students to imagine or describe the process of thinking and learning. To know their thought process, students must build their cognitive abilities. All questions are not only answered by one student alone but can be more than one student. Students can think in the long term and the answer together. Planned through further research, the level of questions developed to arrive at a metacognitive level. Although successful enhanced thinking skills in decision making and creative problem solving but of the process has not reached the student metacognition .

Turning to teachers and students response showed a positive results. Both teacher and student give 50% positive perception when preeliminary learning. After learning process, teacher models respond positively or equal to 95 percent of the application of LBQ while the majority of students gave positive responses with the percentage of yes answers on all aspects of assessment items amounted to 76.7% as show in Figure 1. These results were compared with the percentage of yes answers proposed by the teacher models there are significant differences, or about 18% (95% versus 76.7%). This means that the reliability of students' answers and the answers of teachers still need to be confirmed again.

Figure 1. Student and teacher response to LBQ's implementation

4. Conclusion and Suggestions

4.1 Conclusions

This study investigates the role of physics' questions in the improvement of learning student thinking skills. Based on this empirical study in Indonesia, we draw the following conclusions from our research:

The application of learning by questioning can improve students' thinking skills with the acquisition of gain attributes the increase to 10 thinking skills were in the range of .27 to .73 with an average of .48.

Totally, eight from ten attributes (80%) are consistent and can be improved by LBQ. There skills are analyzing and synthesizing, raises questions, information searching, utilizes concept, makes inferences, generates implications, decision making, and creative problem solving, (c) the teacher models and the students responded positively to the LBQ. Teacher models assessing 95% that LBQ appropriate application of learning to be applied, while the students gave a positive response of 76.7% .

4.2 Suggestion

Based on the findings, conclusions, and deficiencies in research then we write some suggestions in this study :

First of all, the need for the development of metacognitive questions in finalizing of learning materials in the future, which is new in this study was developed in a literal and inferential level, while the level of metacognitive training is merely the beginning. Secondly, in accordance with the planning of further research needs to describe the activities of teachers and students. Thirdly, the need to perform validation related empirical confirmation, clarification, and consistency of the variables that have been obtained in the experiment is limited to the this research. As illustrated in this study were obtained difference in response rate were raised by teachers and students. The last suggestion is related to consider the Questioning Cycle.

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Table 1. Gain acquisition of student thinking skills

	Attributes of thinking skills	Poin acquisition		Gain	Criteria
		S_{post}	S_{pre}		
1	analizing and synthesizing	73	48	.48	moderate
2	raises questions	80	29	.72	high
3	information searching	84	40	.73	high
4	information prosesing	66	52	.29	low
5	utilizes concept	72	38	.55	moderate
6	makes inferences	65	38	.44	moderate
7	makes assumption	56	40	.27	low
8	generates implications	58	32	.38	moderate
9	making decision	62	28	.47	moderate
10	creative problem solving	56	25	.41	moderate
	Average	68.44	38.33	.48	moderate

Gain criteria:

$g > 0,7$ = high

$0,3 \leq g \leq 0,7$ = moderate

$g < 0,3$ = low

(Hake, 1998; 1999; Savinainen & Scott, 2002)

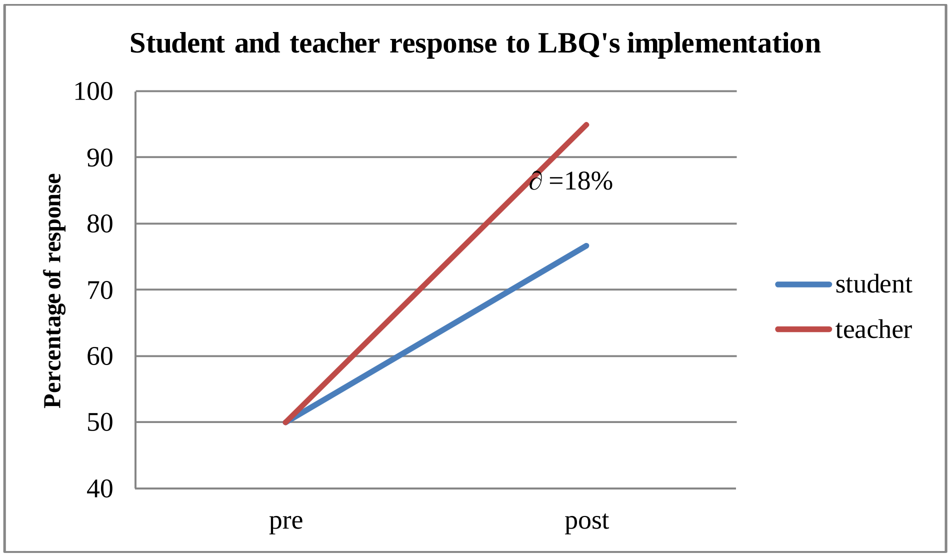

Figure 1. Student and teacher response to LBQ's implementation