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COMPARISON OF STUDENTS' SCIENTIFIC LITERACY IN INTEGRATED SCIENCE LEARNING THROUGH MODEL OF GUIDED DISCOVERY AND PROBLEM BASED LEARNING

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ABSTRACT

This study aims to describe the comparison of students' scientific literacy improvement in integrated science learning through guided dicovery and problem based learning models. The subjects were 8th grade students of State Junior High Schools in Bandung. This research design was quasi-experimental with non randomaized static group pretest-posttest design. The instrument used in this study was multiple choice test and attitude scale. The result shows that the improvement of scientific literacy achievement of students who learned integrated science through guided discovery and problem based learning models did not differ significantly. Integrated science learning through guided disovery models can improve student literacy achievement with the gain of 0.37 (medium category), while by using problem based learning model can improve scientific literacy with the gain of 0.41 (medium category). It can be concluded that the both models of guided discovery and problem based learning can improve students' science literacy.

Keywords: guided discovery, integrated science learning, problem based learning, scientific literacy.

INTRODUCTION

The primary goal of science education curriculum is to provide an opportunity for learners to use their understanding of science in the public debate, make balanced information and decision about socioscientific issues affecting their life (American Association for the Advencement of Science, 2000). This thought underlied the idea of scientific literacy. Robert (in Dawson & Venville, 2009) explained that scientific literacy is the value of the students for life, regardless of the career and scientific needs. Individuals who are literate can be described in a practical way as being able to resolve the practical problems of health and survival; participate in debates and decision making in social practices; get motivated to find out that science is the product of human effort in cultural practices (Shen in Dawson & Venville, 2009). Christenson et al. (2013) refined the idea and considered that the scientific literacy was related to society preparation for the future to make of personal and collective decision on the socio-scientific issue. Scientific literacy is considered as the root of the progressive change of science education (Sadler & Zadler, 2009).

The importance of science literacy in science education has been elaborated, therefore, scientific literacy has been recognized internationally as a benchmark of quality level of science education. The Program for International Student Assessment (PISA) consisting of developed industrialized countries (the Organization for Economic Cooperation and Development, OECD) responded by developing science literacy assessment for children aged 15 years and under. The assessment is also performed in countries that are volunteered to be assessed, including In-

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donesia. The further analysis results of the PISA data is for children in Indonesia resulted in several findings of:

1. The achievement of science literacy of students is low, with the average of 32% to the overall aspect, consisting of 29% for content, 34% for the process, and 32% for the context.
2. The diversity of students' scientific literacy among provinces in Indonesia is relatively low.
3. The ability to solve the problem of children in Indonesia is very low, and it is far behind countries such as Malaysia, Thailand, or Philippines.

The level of students' scientific literacy that is considerably low are caused by several factors. According to Hayat & Yusuf (2006), school learning environment and atmosphere affected students' literacy score variations. Other factors like school infrastructure, human resources and school organization and management also influenced significantly on students' literacy achievement. Firman (2007) also revealed that the low level of scientific literacy is closely related to the gap between applied science teaching in schools and the demand of PISA.

Based on the result of preliminary studies in one of the Junior High Schools in Bandung, it is revealed that teacher still teach science as a separated subject (chemistry, physics, biology), teacher still roles as the center of learning process (teacher center) so the the concept mastery and inquiry ability is rarely trained, teachers only focus on concept mastery and do apply discovery learning and problem-based learning. 40% of students are not being involved in finding the concept of science in learning process, 55% of students state that in learning process they are sometimes given the problems related to daily life, while 51% of students state that the science is taught separately (Chemistry, Physics, Biology). The preliminary study results into the basic assumption that science learning relevance at school is relatively low so it adversely affects the students' scientific literacy. Therefore, some efforts are needed to improve the quality of science teaching to improve students' scientific literacy.

Several previous studies have revealed about the development of scientific literacy in science learning in the classroom. Learning science using socioscientific issue is the learning approach that has important role in promoting scientific literacy (Sadler & Zadler, 2005). Sobard & Rannikmae (2011) revealed that learning by using socioscientific issue made students got difficulty in evaluating the evidence and make decision because of their critical thinking skills are relatively low. The development of critical thinking skills can be done through realistic and relevant learning to support scientific literacy competency domains (Bailin, 2002; Dam & Volmen 2004). Van Aalsvoort (in Sobard and Rannikmae, 2011) also stated that learning by using socioscientific issues that are relevant to the personal, social and global issues is necessary in developing students' scientific literacy. Moreover the development of scientific literacy can also be done through "writing tasks" in learning. Ritchie, et al. (2011) revealed that the students' involvement and interest in "writing tasks" can train basic skills of scientific literacy. In line with the Sadler (2004) research that said the essay on the socioscientific issue contributed effectively in the development of scientific literacy of middle school students.

Based on some of research results, the majority of scientific literacy development of students is performed by using socioscientific issues through learning process. However, in this article the researchers tried to explore the development of students' scientific literacy through integrated learning by using scientific literacy-based model. The model was guided discovery and problem based learning (PBL) models. Guided discovery model was selected for its inquiry in the learning steps. Inquiry steps was suitable to train competence / domain of scientific literacy. While, PBL model was selected because it was able to develop the students' critical thinking skills. Critical thinking skills are important aspects that affect students' literacy skills. The learning topics in this study was "Fluid" that was taught integratedly. The topic was presented to be relevant to the personal, social and global context. Fluid topic was divided into some subtopics consisting of blood pressure, stroke, the buoyancy of fish, and transportation in plants. This article revealed the achievements of students scientific literacy in science integrated learning using model of guided discovery and PBL.

METHOD

The method used in this research was quasi-experimental and the design was Non Randomaized Static Group Pretest-Posttest Design. The use of this design was intended to determine the effect of treatment towards the research subject (Fraenkel et al., 2012). The design can be seen in Table 1.

The research population was all students of State Junior High School in Bandung in the

academic year 2014/2015 and the subject was 70 students that were divided into two groups. The first group got integrated science learning using guided discovery model while the second group used PBL model. Instruments used in this research were the multiple choice questions used to assess students' scientific literacy skills in the aspects of the content and science competencies. The data obtained and dianalsisis quantitatively and qualitatively. Quantitative analysis was conducted on data of students' scientific literacy achievement scores of both whereas the observation of learning process was analyzed qualitatively.

Table 1. Research Design of *Non Randomaized Static Group Pretest-Postest Design*

Group	Pretest	Treatment	Postest
Experiment I	T_1	X_1	T_2
Experiment II	T_1	X_2	T_2

Caption :
T_1 : Pretest to determine initial achievement of students' scientific literacy
X_1: Science learning using guided discovery model
X_2: Science learning using problem based learning model
T_2: Postest to determine achievement of students' scientific literacy after treatment

RESULT AND DISCUSSION

Scientific literacy is defined as the ability to use scientific knowledge, to identify questions and draw conclusions based on the evidence, in order to understand and make decisions regarding to the nature and its changes resulted from human activity (Rustaman, 2003). In accordance with the definition, the test questions (items) require the use of science competency in the context by involving the application of scientific knowledge. Assessment of scientific literacy in PISA does not assess the context, but the competence, knowledge and attitude that are related with selected science contexts in the assessment. Therefore, this research assesses the achievements of scientific literacy in the aspect of knowledge, competence and science.

The treatment in this research was integrated science learning using guided discovery model for experimental group I and integrated science learning using problem based learning models for the experimental group II in four meetings. Tests was given in the first meeting before learning process and in the last meeting after learning process. Test materials were same for both tests, they consisted of 26 items of multiple choice questions. Overall achievements of students' scientific literacy who obtained science integrated learning using guided discovery and PBL models both before and after treatments were good ($N = 80$, $p > 0.025$), meanwhile the students' scientific literacy in the two groups improved 37% for guided discovery model and 41 % for PBL model.

Students' scientific literacy of both groups was well improved. However, after conducting difference test to the post test average of both groups, it was found out that there was no significant difference in students' scientific literacy skills (Figure 1). The result indicates that the implementation of guided discovery and PBL models in integrated science learning were able to be used in improving students' scientific literacy.

Improvements of scientific literacy aspects occured because of the integrated science lesson based on scientific literacy for both group could encourage students to construct and make connections between their knowledge and its application in daily life. This is consistent with Holbrook (2003) that stated "science will easily learned when the material is reasonable in students' point of view and also related to human life, interest and aspiration".

Implementation of integrated science learning by using guided discovery and problem based learning models also gave the opportunity to students to work together with other groups in doing the investigation, so that activity can develop their process and social skills. The collaboration between investigation and peer discussion can develop thinking and social skills. Vigotsky (in Ibrahim, 2012) said that social interaction occured between students and their friends can help to form new ideas and enrich their intellectual. He also said that if students interact with others who have better understanding, they will be able to achieve the level of development that is slightly above its actual capabilities.

The results also showed that the learning model of discovery and PBL provided opportunities for students to learn thinking analytically and try to solve their problems. This provides a positive impact on the thinking competence and students' understanding that will bring positive contribution to their sceintific literacy. This is in line with the results of several studies (Brickman, et al, 2009; Balim 2009; Alfiery 2011, and Nbina, 2013) which stated that learning proces that gives students the chance to be actively involved in gathering knowledge process in the deductive

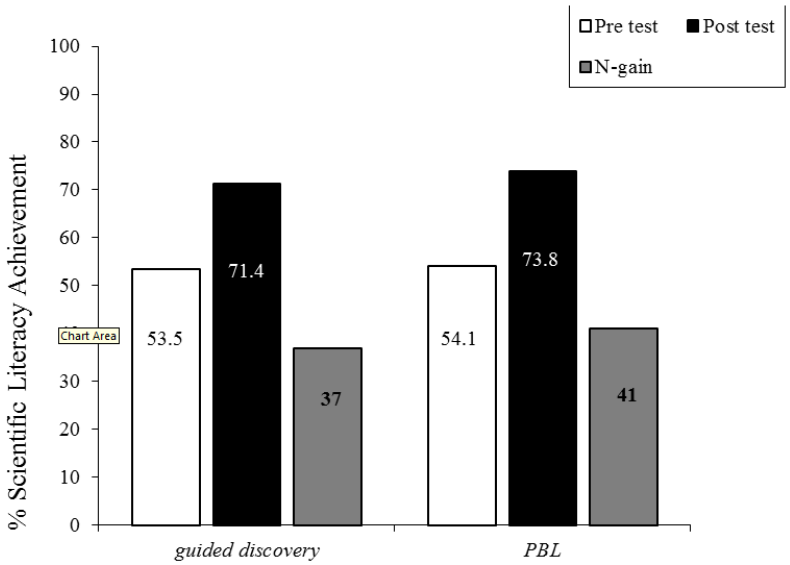

Figure 1. Overall Students' Scientific Literacy. The difference test of score average showed no significant difference between groups using guided discovery and PBL models. (*** $p > 0,025$)

or inductive analysis can develop their thinking skills and cognitive ability, meanwhile the knowledge obtained will be more meaningful.

Scientific literacy that were examined consisted of knowledge and science competence. Analysis of scientific literacy knowledge conducted to determine the profile of Fluid material mastery. Fluid material is divided into several topics of blood pressure, abnormalities in the circulatory system, the buoyancy of fish and transportation in plants. Figure 2 shows the improvement of students' achievement for every content material that was discussed in the learning process. Overall, integrated science learning using guided discovery and PBL models can improve science content mastery achievement taught in the learning process. The highest improvement was in transportation of plant content of both groups that used guided discovery learning and PBL models. Results of students' activity observation showed that the dominant activity during the learning process with guided discovery and PBL models was in the experiment activities and teacher's explanation. This means that the experiment conducted by student contributed positively to students' understanding of this content. Through experiment, students were given the opportunity to discover the concept of transportation of plants. After the experimental activity was completed, the teacher also gave reinforcement in the concept of capillarity in plants through the video. The experiments conducted by students in both groups followed the steps in the scientific process so that it can help students master the concepts learned. This is in line with Swakk et al. (2004) which states that learning using empirical cycle (the process approach) for example collection and classification of information, formulation of hypothesis, making predictions, interpretation of experimental results and making conclusions to improve and enhance the skills of inquiry and the students' cognitive processes; students were given the opportunity to learn thinking analytically and try to solve their problems.

The use of video in learning process was also considered easier for students to understand abstract concepts in transportation of plants material. The use of multimedia like video in learning process was able to improve the intensity of interactive communication, creative dialogue and students' discussion, thus triggering the formation of knowledge building in every students. The results of this study is consistent with Fan & Geelan (2012) which stated that the use of multimedia in science learning can enhance students 'understanding, science process skills and students' understanding of the nature of science. Those aspects are part of scientific literacy domain consisting of context, the competence of science and knowledge of science. Moreover, multimedia learning can contribute to the development of quality science learning and improve students' scientific literacy in the future.This study do not only reveal the students' understanding of fluid material, but the more interesting for us to observe is how is the students' thinking competence after obtaining science learning using guided discovery and PBL models. This is necessary because a person is said to be literate if he is not only proficient in conceptual terms, but also

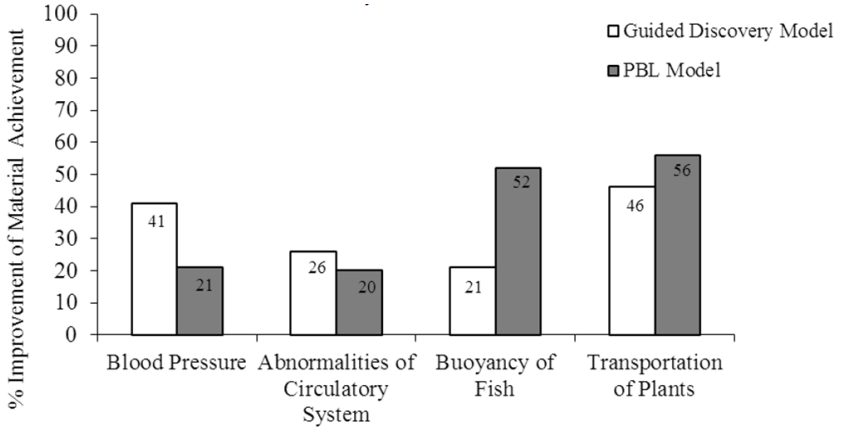

Figure 2. Profile of improvement content mastery achievement of fluid material after the learning process used Guided Discovery and PBL models

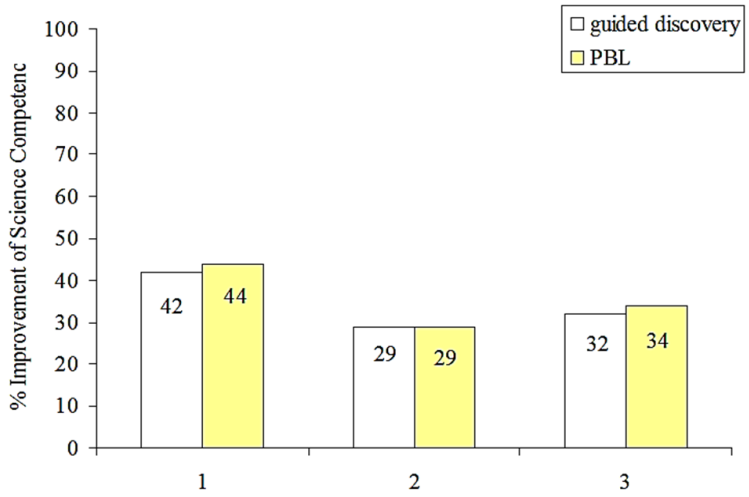

Figure 3. Improvement of students' science competencies after using guided discovery and PBL models in science learning (1. Identifying Scientific Issues; 2. Explaining Phenomena Scientifically; 3. Using Scientific Evidence)

their way of thinking to solve the problem using their knowledge. This research will be unfair if it only reveals of domain of content, therefore, the research results that will be subsequently discussed are science competence of students. Student competence revealed in this research refers to the scientific literacy indicators recommended by the Programme of International Student Assessment (PISA) in 2012. They are "Identifying scientific issues", "Explaining phenomena scientifically" and "Using scientific evidence". Overall performance shows improvement of students' science competencies after using guided discovery and PBL models in science learning can be seen in Figure 3.

Figure 3 shows that the achievement of students' science competencies overall showed encouraging results. The research revealed that the indicator of "identify scientific issues" improved 42% for guided discovery model and 44% for PBL. Then for the indicator of "explaining scientific phenomena" it improved 29% for both models, and for the indicator of "using scientific evidence it improved 32% for guided discovery model and 34% for PBL.

The improvement of students' competence in each indicator was because the implemented learning model emphasized on students' independency and thinking skills. Basically, the model is applied in the classroom to give students an opportunity to practice recognizing authentic scientific issues in learning process to solve these problems through systematic stages. Hence students' scientific literacy skills of science process aspects has improved after implemented learning process. This is in line with research finding of Rubini et al. (2016) that revealed learning that facilitates students to solve problems can improve authentic domain process/students' competency significantly.

Moreover, the developed model is also supported with multimedia such as video, animation and film. The use of multimedia in learning process can motivate students to learn. The role of motivation developed from individual is very important the knowledge building depends on the students' motivation. The use of multimedia also can help students in learning process of the material that can not be seen directly in the classroom, for example the theory of the formation of the universe, the theory of the formation of the solar system, the movement of the planets in the solar system. This is consistent with the statement of Camberlain (2012) that stated the multimedia simulations in learning process can help students visualize objects and processes that can not be displayed directly in the classroom. Further it is explained that the availability of the technology allows students get richer learning experience during lesson through the use of simulation in the learning concept material.

Based on previous elaboration, the use of multimedia in learning process that shows the simulation gives an important role in the development of students' scientific competence. The result is consistent with several studies that reveal the use of interactive multimedia is potential in developing the scientific concepts and students' science process skill (Evan, Yaron and Leinhadt, 2008).

The implementation of integrated science learning using guided discovery and problem based learning model can improve students' scientific literacy skills both aspects of content and science competency in the medium category. This is influenced by several factors of (1) the big number of students so it took too much time to help them find a concept or problem solving, (2) integrated science learning required students to understand the concepts of various disciplines, students who were not familiar with that would have difficulty in linking concepts across disciplines, (3) during the learning process with guided discovery and problem based learning models students are required to act like a scientist, it was difficult for less intelligent students because they had to think or express the relationship between conceptual concept, which in turn leading to frustration, (4) students were also not familiar with the provided worksheet, because it required to do simple research that required mindset readiness then students who were not familiar with these conditions can experience the boredom, (5) goals and objectives of guided discovery learning can be disrupted by students and teachers who were familiar with traditional teaching method.

CONCLUSION

Based on the analysis it can be concluded that the integrated science learning using guided discovery and PBL model can be used to build students' scientific literacy in both aspects of content and science competency. The achievement of content mastery and students' science competency in both groups after learning process has improved quite satisfactory, this is because the learning (both guided discovery and PBL) is designed by adopting scientific approach methods, prioritizing independent learning, and promotes students' thinking skills. While the role of the multimedia in learning process facilitate students to understand abstract concepts.

From the research results, the science learning in junior high school should provide inquiry skills to students. If the student has been trained with the activities of inquiry, it can facilitate teacher in implementing integrated science learning using guided discovery and problem based learning model. This study was not used the authentic assessment in revealing students' scientific literacy skills. Therefore, if you intend to conduct similar research it is necessary to develop an authentic assessment to reveal students' scientific literacy skills.

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