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# SCIENCE PROCESS SKILL DEVELOPMENT: POTENTIAL OF PRACTICUM THROUGH PROBLEMS BASED LEARNING AND AUTHENTIC ASSESSMENT

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Science essences are product, process and scientific attitude. As a process, science is a used procedure to study the object of study, to discover and to develop science products. It seems that Indonesian education is not focusing on developing students' science process skills. Therefore, the researchers employed a problem-based learning model through an authentic assessment based practicum to improve students' science process skills. A Quasi experimental design with pretest-posttest nonequivalent control group design was applied in this study. Biology educational students of STKIP Persada Khatulistiwa Sintang, West Borneo, Indonesia were taken as the population. The participants of the research were 60 students from two classes of animal physiology, each class consisted of 30 students. Essay test was applied to measure the science process skills. Essay test questions cover both science basic process skills and integrated science process skills. The research result showed that problem based learning through practical and authentic assessment affected the students' science process skills and there were significant differences between the problem-based learning model through authentic assessment based practicum with problem-based learning model.

Keywords: Problem-based learning, practicum methods, authentic assessment, science process skills, animal physiology

## INTRODUCTION

Science essences are product, process, and scientific attitudes. As a product, science is a set of knowledge and a set of concepts. As a process, science is a used process to study the object of study, to find and develop the science products. As an application, science theories would produce a technology which is able to provide life convenience (Trianto, 2014). Science as a process is using the scientific method to study the object of study, discovering and developing science products. Scientific method is systematic ways that involve science process skills in investigating a problem, for example, making observations, formulating hypotheses, designing experiments, and others (Sukardjo, 2008).

Science learning was the complex activities that should be done to acquire scientific knowledge, science skills as well as scientific attitude (Subamia, 2012). Teaching effective science which is determined by science process skills is one of its education goals. Science education should include the emphasis on hypothesizing, nature manipulating, and data-based reasoning. New reformation offers science process skills teaching for all students. Educators recognize these skills

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values in line with personal, intellectual, and social development. Some educators emphasize the importance of science process skills teaching in science education (Özgelen, 2012).

In general, Indonesian education is not trained to develop science process skills. Therefore, the researchers willing to apply a new model to develop students' science process skills. Dahar (1996) explained that science process skill is the student's ability to apply the scientific method in understanding, developing, and discover science. Learning biology needs science process skills because learning biology deductive patterned sometimes requires creative process and inductive. Science process skills involve cognitive skills or intellectual, manual, and social. Cognitive and intellectual skills involved because by involving process skill, students use their minds. Manual skills clearly involved in the process skills because they involve students' skills in using the equipments and materials, measurement, preparation or equipments assembly. Social process skills intended the students to interact with each other in carrying out the process skills teaching and learning activities such as, discuss the observation results (Rustaman, 2005).

Özgelen (2012) stated that in our daily life, students formulated a hypothesis, or make statements of nature phenomena. It requires accurate basic skills based on our observations so we can draw conclusions. In analyzing the data, the other processes skills, such as making predictions, concluding, and making hypotheses from the collected data are required. To be able to perform all of these activities, the students must have experience in observing, classifying, and measuring or interpreting data.

One of the parts of the scientific expertise is to have the process skills associated with the scientific inquiry. Expertise inprocess science and integral skills has effective role in science teaching. The expertise is certainly not innate or inborn. Become an expert, a person must receive guidance in scientific investigation, and hemust perform a lot of proper practical activities in using scientific inquiry skills. In the development of scientific skills, the students need inquiry skills with appropriate and adequate guidance in learning (Ango, 2002).

Science process skills are divided into two, namely basic science process skills and integrated science process skills. Basic science process skills consisted of observing, applying the correlation of space or time, concluding, performing measurements, communicating, organizing and predicting. Integrated science process skills consisted of identifying variables, defining operations, formulating hypotheses, interpreting the data, conducting experiments, formulating models, and presenting the information (Özgelen, 2012). In this study, the researchers measured both of the science process skills.

To achieve science learning goals as described above, science learning should emphasize the students'whole involvement to be active in science learning. Learning science should bein that way to be able to correctly create the science knowledge and skills. The science process learning should emphasize on providing direct experiences to develop scientific exploration and the understanding of competencies (Subamia, 2012). One of the methods for developing science process skills is practical methods.

Practicum is a fundamental part of every knowledge branch and especially for science. Practicum is currently an important role in confirming the taught theory in the classroom (Reid, 2006). Arifin (2003) suggest that practical method supports the learning process activities in finding certain principles or explaining developed principles. Practicum will be effective if it is well planned, giving the opportunity to choose an alternative procedure, designing experiments, collecting data, and interpreting the obtained data. According to Trowbridge and Bybee (1990) practicum is an important activity in developing science process skills, solving a science problem, and testing the students'

hypothesis. As submitted by Gabel (1994), laboratory activities also provide opportunities for students to develop their skills.

Effective laborator requires these following conditions: the teachers must prepare and plan for the practicum before learning activity and they must have experience in experimenting or lab work that will be done in classroom; students should have the initial conceptual or experimental knowledge; students should be provided the environment to use and to engage then their knowledge; basic and advance science process skills should be used; environment must be established between the taught subjects in lab with their daily life; and laboratory environment must introduce innovations. Furthermore, laboratory safety must be effectively maintained and safety awareness should be raised among the students (Feyzioğlu, 2009).

There are four simultaneously trained skills through laboratory work, namely: (1) Content skills e.g. chemical. There is an opportunity to make a real chemistry, to illustrate the ideas and concepts, to expose the theoretical ideas to empirical testing, to teach new chemical content. (2) Practical skills. There is an opportunity to handle the equipment and chemicals, to learn safety procedures, to master specific techniques, to measure accurately, to observe carefully. (3) Scientific skills. There is an opportunity to learn observation skills and deduction skills and interpretation. There is an opportunity to appreciate the empirical place as an investigation evidence source and learn how to design experiments that offer original insights into chemical phenomena. (4) General skills. There is a skill that has many benefits to gain: teamwork, reporting, presenting and discussing, time management, developing ways to solve problems (Reid, 2006).

The weakness of general practicum is it does not involve or is not associated with the environment problems. Practicum just proves the theory and is not associated with the existing environment problems (Duda, 2010). Therefore, in this study, the researchers integrated practicum method into problem-based learning model. Problem-based learning is an associated learning from authentic problems that exist in the environment and resolved through learning in a group (Arends, 2008). Many results showed that PBL is a learning approach that offers potency to help students to develop an understanding of flexible and lifelong learning skills (Silver, 2004).

The purposes of the PBL are to help students to develop (1) a flexible knowledge, (2) the ability to effectively solve the problems, (3) independent learning skills, (4) effective collaboration skills, and (5) intrinsic motivation (Silver, 2004). Based on Keil, et al.'s (2009) research, PBL provide opportunities for students to develop the basic process skills and integrated with the environmental health material context. According to Denhaan (2011), in order to improve students' professional competitiveness they should be provided the qualified research skills training, such as giving them a problem to be solved. The researchers added authentic assessment to motivate students to learn and engage then the concept and be able to develop their own skills.

The aims of authentic assessment application are improving and increasing the learning quality because authentic assessment is better, planned, directed, and focused. The emphasis of authentic assessment lies on the process of information acquisition and information utilization. Information or explanation obtained through teachers and students cooperation and they used the information to repair and improve the following learning quality (Mansour, 2011).

The product performance assessment and behavioral–based measurement done based on designing areal-life context or conditions atmosphere in which knowledge or skills are actually applied. Thus, authentic assessment can be defined as a specific cognitive process (inquiry) and the product (knowledge) was considered important in the outside of school life perspective. Authentic assessment is often associated with the real life situations mimicry task assessment, but it also has a

meaning as aligned assessments with the curriculum and effective assessment that supports learning (Palm, 2008). As stated by Marhaeni (2008), authentic assessment is able to give a real picture of the students' situation and at the same time provide direct experience for them.

Based on the problems above, the researchers chose "developing science process skills: a study to maximize the practicum potential through problem-based learning and authentic assessment" theme where in this study PBL model integrated with authentic assessment based practical methods. The application of the model on animal physiology subjects that includes structure and function of cells in general, the food, the digestive system, blood, circulatory system, respiratory system, excretory system, coordination system nervous system of coordination of hormones, osmoregulation, thermoregulation and the senses, which includes: sight, smell, skin, hearing, and balance material. The study was conducted for one semester at the Biology Education Program, the academic year 2013-2014 in STKIP Persada Khatulistiwa Sintang.

## METHOD

Quasi-experimental design with pretest-posttest nonequivalent control group design (Borg & Gall, 1983) was applied in this study to compare the effect of PBL model through authentic assessment based practicum with problem-based learning to biology students' science process skills in higher school of teachers and education

Persada khatulistiwa Sintang West Kalimantan, Indonesia.

*Sample of Research*

STKIP biology students in Persada Khatulistiwa Sintang West Kalimantan were chosen as the population of this study. Therewere 60 participants of two classes of animal physiology students, 30 students of the experimental class consisting of 17 females and 13 males and 30 students of the control group consisting of 16 females and 14 males. Based on the grouping test, the participants of this study were considered as homogeneous initial academic ability students, tested by equality test.

*Instruments and Procedures*

Essay test was applied to measure the science process skills. Essay test questions cover both science basic process skills and integrated science process skills. Content validation and construct validation were conducted before using instrument. The research procedures consists of several stages, namely: the first stage, providing an early science process skills test for both classes. The second stage was giving a treatment by using different learning models. Experimentclass taught by using problem based learning through authentic assessment based practicum and control classroom taught using problem-based learning. Learning took place during one semester for each treatment. The third stage was giving the science process skills final test forboth classes. The fourth stage was science process skills test results were analyzed and discussed. The research design showed at Table 1.

Table 1
Quasi Experimental Research Design

| *Pre-test* | *Group* | *Post-test* |
|---|---|---|
| $T_1$ | $X_1$ | $T_2$ |
| $T_3$ | $X_2$ | $T_4$ |

Where,

$T_1$ and$T_3$: Pre-test

$T_2$ and$T_4$: Post-test

$X_1$: Model PBL through practical and authentic assessment

$X_2$: Problem-based Learning Model

*Data analysis*

The data of this study were data about science process skills at the pre-test and post-test by the psychomotor test by essay test. Essay test questions cover both science basic process skills and integrated science process skills. Anacova test Analysis was employed to determine the effects of the model usage to the students' science process skills using SPSS 20.

**FINDINGS**

Students' process skills pretest and posttest data in both problem-based learning through authentic assessment based practicum and problem-based learning treatment were the obtained data of this study. From both research data it is seen that in pretest data found no significant difference between problem based learning through practicum supported by authentic assessment and problem based learning, whereas posttest data showed the difference between the two treatments. The data were analyzed using Anacova test. Summary of students' science process skills Anacova test results presented in Table 2.

Table 2
Summary of Students' Science Process Skills Anacova Test

| Source | Type III Sum of Squares | Degree of freedom | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Corrected Model | 438,210[a] | 2 | 219,105 | 12,549 | <0.001 |
| Intercept | 1817,052 | 1 | 1817,052 | 104,069 | <0.001 |
| Xkps | 120,810 | 1 | 120,810 | 6,919 | 0,011 |
| Model | 311,697 | 1 | 311,697 | 17,852 | <0.001 |
| Error | 995,224 | 57 | 17,460 | | |
| Total | 400294,500 | 60 | | | |
| Corrected Total | 1433,433 | 59 | | | |

Based on the students' science process skills Anacova test results as presented in Table 2, it showed that the learning model affected the students' science process skills, this was due to the significant value in the model < 0.001 significantly below the constants of 0.05, thus it could be said that there was significant difference between students' science process skills taught using problem based learning through authentic assessment based practicum with problem-based learning model.

**DISCUSSION**

Based on the research results it was found that the students' science process skills taught using problem based learning through authentic assessment based practicum significantly different with the problem-based learning, this was because the problem-based learning through authentic assessment based practicum emphasis on three major components, namely analyzing the problem, doing practicum, and making the product. The first component affected science process skills model was analyzing the problem, as expressed by Akcay (2009), PBL has an important role, which can help students to develop the thinking ability, problems solving, and intellectual skills through the students' involvement in the real experience or simulation. According to Kwan (2000) problem-based learning encourages thinking and active integration of information and has improved research skills. Sungur (2006) states that PBL students tend to participate more in doing the task than control group because of the challenge, curiosity, and the mastery. They seemed to accept biology as an interesting, important, and useful subject.

The second affected component to students' science process skills was doing practicum. Theoretically where laboratory was expected to support the development of certain skills activities, such as process skills, motoric skills and the establishment of a scientific attitudes, especially the development of interest to the investigation, research, and interest in the nature greater depth study (Hudha, 2011), Laboratory activities also provide opportunities for students to develop the skills and ability to think logically (Gabel, 1994).

According Poppy (2010) practical exercises are used to support students' basic skills aspects development goals through the equipments usage training, environmental observing, measuring, and other activities. Thus, practicum exercises can be used to sharpen the students' skills in doing practical work both in the laboratory and outside laboratory. According to White (1996: 766-770) through practicum students more easily understand the learned concepts in the classroom and concepts be more meaningful so it is easier to remember. Roth (1992) confirmed that practicum can be used as a means to improve the concept understanding and improve the students' misconceptions. According to Vollmer (2005) by practicum, students perform scientific activities such as observations, experiments, and related to learning demonstrations.

The third component which affected students' science process skills was giving authentic assessment. Authentic assessment is expected to stimulate students in developing the skills and relevant competencies for their future work life. Authentic assessment is important to prepare students for the unpredictable work life (Gulikers, et al, 2006). The needs to contextualize the tasks assessment are interesting; this appropriate and authentic real life is one of the important elements of the new assessment model (Birenbaum and Dochy, 1996 in Gulikers, et al., 2006).

Wiggins (1990) emphasized the importance of real-world task or representative asks, for example, researching, writing reports, and compiling a portfolio with a slightly expanded criteria in order to incorporate the collaboration idea among students and then suggested that the tasks and scoring should be quite complex. Increased psychomotor results is caused by the students learning experience in the authentic assessment as a whole (collection of learning experience) in the student's mind in knowledge (cognitive), skills (skills), and values, and attitudes (affective) form (Dawn, 2004).

Problem-based learning has lower science process skills value than problem based learning through authentic assessment based practicum because in PBL model, the problem solving is not focused on one point. Kirschner, Sweller, and Clark (2006) stated that although problem-based learning can help students to acquire the meaning of the subject matter, but the theory of cognitive

load indicates that the free exploration of a very complex environment can generate workload memory becomes heavier which may be detrimental to learners. Furthermore Wood (2003) revealed the PBL short comings, namely (1) tutors who unable teach will find PBL causes trouble and frustrating, (2) other resources, a large number of students need to access the resource library and computer simultaneously, it will become difficult for students, (3) too much information, the students may not be sure how much for self-directed study in doing and what information is relevant and useful.

From this research results it can also be seen that although the problem-based learning has a lower value than the developing model, but the posttest value significantly increased from the pretest value. It was because the application of problem-based learning syntax consistent in solving the problem. As expressed by Arvyaty and Saputra (2013) problem-based learning model is learning the subject knowledge in using and developing science process skills context. Problem based learning model emphasizes the learning process because the syntaxes encourage students to develop science process skills.

Science process skills are the scientists thinking ability to construct knowledge in order to solve problems and formulate results (Özgelen, 2012). Science process skills cannot be separated from the science practice and play an important role in both formal and informal learning science content (Keil et al., 2009). Learning science emphasizes providing direct learning experience by developing science process skills so that learners can explore and understand the nature. In addition the aims of the usage and the development of science process skills and scientific attitudes in science areenable the students to understand the concepts and be able to solve the science problems. Science should be taught in an integrated way and cannot be separated from other science materials (Prasad, 2011).

## CONCLUSION

Based on the research results and discussion, researchers concluded that there was effect of problem based learning through authentic assessment based practicum to the students' science process skills, it can be seen from the significance value <0.001 less than 0.05. Thus, it can be concluded that there are significant differences between the PBL models through authentic assessment based practicum and problem-based learning model. This was because the problem based learning through authentic assessment based practicum consisted of three main components to learn, namely analyzing problems, practicum, and making products and thus can improve students' science process skills. For the teachers and other researchers, a blended learning model is problem based learning through practicum authentic assessment and it was proved effective in increasing students' science process skills. So, the model can be used for teaching or for further research.

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