Laboratory Practice and its Contribution in Constructing Higher-Order Thinking Skills: A Case Study in Basic Chemistry Course

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Abstract

A study to examine the contribution of laboratory practices in constructing higher order thinking skills, in basic chemistry course in Lampung Provincehas been done. This research method is a case study, which conducted through observation, documentation and questionnaires. The subjects of this study were 41 students of Chemistry Education Study Program that contracted basic chemistry course. The results showed that the basic chemistry courses strategy are lectures and interactive discussions. The largest percentage of questions assessment component of theory was to analyze and solve problems. Laboratory practices are verification, which assessment involves the ability to remembering and understanding. An average value of theory component 39.53 and average value of practices component 77.37. In conclusion, activity of laboratory practices do not contribute to construction of ability to analyze and solve problems which a higher-order thinking skills. This study provides insight for researchers and teachers to develop chemistry laboratory practices strategy.

Keywords: laboratory practice, higher-order thinking skills, case study, basic chemistry course

Introduction

Laboratory activities has been recognized as a unique learning environment where learner scan work to get he rin small groups (Hofstein and Lunetta 1982; De Boer1991; Lin2007). Research shows that learning is more meaningful when learner sare involved in laboratory activities (Domin, 2007 ; Garnett, PJ, Garnett, PJ & Hacking, MW, 1995; Hodson, 1990; Hofsteinand Lunetta, 1982 & 2004; Lazarowitz and Tamir, 1994; Lunetta, 1998; Tobin, 1990; Abrahams and Millar, 2008); has the potential to increase the constructive social relationships and positive attitudes, cognitive growth and skills (Hofsteinand Lunetta, 1982 and 2004; Lazarowitz and Tamir, 1994). Also provides end or semen tto train higher-order thinking skills (Bybee, 2000; Hofsteinand Lunetta, 2004). This study reviewing the contribution of laboratory practices in constructing a higher-order thinking skills in basic chemistry lectures.

Method

This study was conducted in Chemistry Education Program in Lampung Province Indonesia. The subjects in this study were college students Academic Year 2013 that contracted the basic chemistry lectures which amount to 41 people. This research method is a case study. Data collection techniques used were technical documentation of the syllabus and lesson plans; practical guidance; question quiz; midterm exam; and final exams and; a list of the students' scores; observation; and questionnaires.

Result and Discussion

Based on the planning document lectures, the lecturer responses, and observations result indicate that the lecture method used is lectures and interactive question and answer session along with exercises that conducted with discussion groups. There are 8 titles in the basic chemistry practicum guidance, each practicum title contains: the purpose of the experiment; short theory, tools and materials, experimental procedure, observation results were equipped with empty observation result tables and evaluation. The response of the students to the practicum implementation is presented in Figure 1.

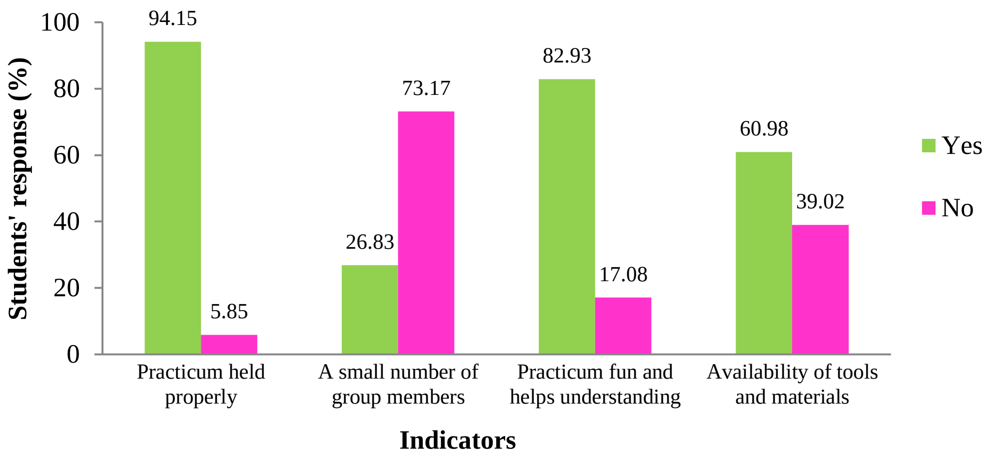

Fig 1. The students' response to the practice implementation

Cognitive domains in the assessment of theory component questions are to analyze that involves problem solving (52.17%), 39.13% applying, and understanding 8.7%. It is assumed that the assessment on the theoretical aspects is measuring the ability to analyze and solve problems.

Exam questions practicum consists of essays and short answer, contains questions about the definition, the function of the tools or materials in an experiment, reaction equation which the reactant is the same as reactant during the experiment, and counting that only manipulated its numbers. Assessment of the practicum activities only measures the ability to remember and understand. Average data value of theory and practicum are presented in Figure 2.

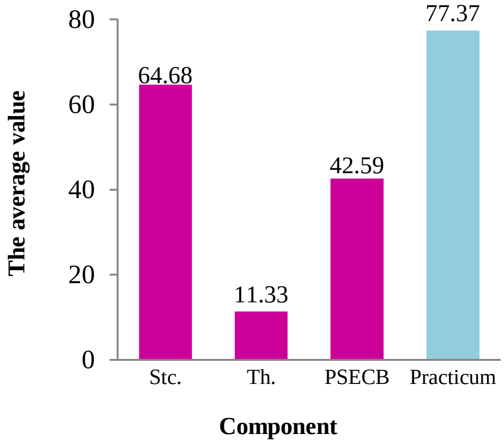

Fig 2. The percentage of the average value of each subject and practicum (Stc: Stoichiometry, Th: thermochemistry, PSECB: Periodic system of elements and chemical bonds)

Competition in the 21st century requires not only high intellectual ability, but also higher-order thinking skills, including problem-solving skills (Stiggins, 1994; Bell 2010). Therefore, the learning process should equip students with that ability to be able to solve the problems faced in the world of work later. Fact low value of the average theoretical components that is39.53; when associated with the capabilities required in the assessment on this aspect, indicating the low ability of the students in analyzing and solving problems. Low ability to solve this problem can be studied from two factors that are lecturing process and practicing implementation. In this paper we examined the contribution of laboratory practices in constructing a higher-order thinking skills.

According to the nature of science as a process and product; through a process of observation, classification, proposed a hypothesis, experiment, and theory building, to be acquired product knowledge includes facts, concepts, theories, principles, and laws. Therefore, ideally through experiments students can master the concepts, theories, laws, and principles. In addition, laboratory practices may change misconceptions; foster scientific attitude and attitude toward chemistry lessons; train higher-order thinking skills; and to develop self-learning ability. (By bee, 2000; Hofstein and Lunetta, 2004; Bopegedera, 2011; Smith, 2012; Sesenand Tarhan, 2013). However, the facts shown in Fig. 2 show the gap between theory and practical values (39.53 and 77.37). This fact is also contradicting with the response stating that the student lab activities held properl y(94.15%) and help the understanding(82.93%).

An explanation of why lab work did not contribute to the ability to analyze and solve problems is as follows. Based on the assessment matter about the practicum component that only demanding the ability to remember, and understand, so acquisition value of the average lab (77.37) does not describe the higher-order thinking skills. Moreover, the practicum guidance has been equipped with purpose of the experiment, short theory, tools and materials, experimental procedures, and empty observations result tables filled by students; so that the basic chemistry practicum are verified. Based on students response, the practicum held properly, even though the number of tools and materials are limited, so it is done in large groups. This means in practical implementation, students just follow the steps to prove the theory without being given the opportunity to develop his ideas in doing practical work, and not all students are actively involved in the practicum.

According to Domin (1999) there are four styles of laboratory teaching that are commonly used ; namely expository, inquiry, discovery, and problem-based. Practicum expository or verification is the most popularly applied in the field of science, including chemistry (Domin, 1999; Kilinc, 2004; Singer, Hilton, Schweingruber, 2005; Cheung, 2007; Smith, 2012). In this model laboratory work, lecturers explain the concepts related to the material that will beinvestigated. The students follow the specified procedures, so that they get the results that are already known previously, as a result they do not have a deep understanding of the design of experiments. For learners, laboratory work means manipulating equipment but does not manipulate ideas (Hofstein & Lunetta, 2004). The results obtained are usually only used for comparison against the expected results (Tamir, 1977). Learners are not encouraged to reconcile the results, or faced with the challenge of predicting naively (Pickering, 1987). Practicum model like this place very little emphasis on the thought (Domin, 1999; Smith, 2012), a means of becoming a conceptual changes bachelors that ineffective (Domin, 1999), and unrealistic in describing scientific experiments (Merritt, Schneide, and Darlington, 1993). In fact, laboratory experiences supposed to expose learners critically thinking, planning, analyzing, synthesizing and must developing an awareness of wholeness data and also appreciate the uncertainty of measurement. This explanation indicates that the practicum activities in the basic chemistry course are not making students actively thinking. At the time of practicum, the student's attention is only focused on resolving step by step of the experiment technically (hands-on), without thinking why and how (minds-on) the process is done.

Conclusion

Based on the analysis on the results of the study concluded that the activities of laboratory practices do not contribute to construct the ability to analyze and solve problems, which is a higher-order thinking skills. This study provides insight to researchers and educators to develop chemistry laboratory practices strategies.

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