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Implementation of 5E Learning Cycle and Performance Assessment Completed with Self- Assessment on Physical Chemistry Experiment

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ABSTRACT

The aim of the research were to describe and study the effect of applying learning cycle (5E), performance assessment, self-assessment on physical chemistry experiment. The research method was qualitative descriptive approach. Subjects of the research were students who take physical chemistry experiment course in the academic year 2014/2015. Physical chemistry experiment is a practical course and the students consider this course was difficult, not applicable, merely calculation without meaning. The research was conducted on 6 experiments designed using the learning cycle (5E) and at the end of the experiment, students filled out a self-assessment, and final exam was performance assessment. Implementation of the program could improve practical skills, understanding of the materials, student interest and student positive respond.

Key Word: learning cycle (5E), performance assessment, self assessment, physical chemistry

INTRODUCTION

One of the bachelors of chemical education competences is having practical skills and overcome chemistry material. Practicum courses are organized to support competency achievement. Based on observation and evaluation, many problems was found in the implementation of practicum lecture and it have to get alternative solution.

The main problem of the practical skills and understanding of materials of the students are still low. Frequently, students are still wrong in the election, the use of laboratory equipment, data analysis, and understanding of the principles and theories. The causes of lowing practical skills and undertanding of materials of the students were: 1) most of the student did not follow the procedures while doing practicum, 2) practical guide was not contextual, 3) the students did not understand the urgency of the practicum courses yet, 4) the final exams were still carried out in written.

One of the core courses that support the achievement of practical skills competency and mastery of chemistry lecture is physical chemistry experiment. Compare with other subjects, physical chemistry experiment has bigger problem. According to the students' perceptions, physical chemistry experiment is not contextual, less applicable, difficult to understand, and it is merely calculation without meaning. From the experiment report and exam results of students, it could be seen that after the experiment, the students did not understand the basic principles of laboratory work.

Currently, physical chemistry lab guide does not effective to help the students understanding basic

purpose and experiment data analysis. This is because the guidelines are not contextual, so the student felt difficult to understand the meaning of the practicum. From the assessment system, the assessment was not in accordance with the competence to be achieved. Physical chemistry emphasis on psychomotoric competence achievement, but the final test done only measured cognitive ability. This leads the students less improve practical skills.

Implementation of the practicum course is very important to support the achievement of competence. Practicum courses are for strengthening, proving, finding theory gained through lectures in class. It needs remedial efforts to improve the implementation of the experiment and practicum assesment system. This research applied the learning cycle (LC) 5E and performance assessment completed with self-assesment to address on learning process on physical chemistry experiment course, specifically and other experiment courses generally.

LITERATURE REVIEW

LC is a learning model that was originally developed by Robert Karbles in 1960. LC is widely applied in science learning. Many researches were conducted to study the effectiveness of the application of LC. The application of LC afforded positive influence of the understanding of scientific concept, perspectives and attitudes towards science. LC continues to be developed, until in 1993, the Biological Science Curriculum Study (BSCS) enhance the step of the LC into 5 stages (Qarareh, 2012).

The stages of the LC (5E) include: 1) engagement, interest and curiosity generating stage of the students, 2) exploration, this phase gives the students opportunity to work together to do experiment, verify prediction, observation, collect and analyze the data to make conclusions to answer arising questions, 3) explanation, the students explain the concept and describe the results of the experiments, 4) extension or elaboration, extending and applying the concepts and skills they learned in a new situation, 5) evaluation, carried out on the knowledge, understanding concepts, acquired competencies, the students can evaluate themselves by asking open-ended questions and seek the answers through observation, evidence, and obtained explanations (Marek, 2008; Qarareh, 2012; Hanuscin and Michele, 2007).

Brown and Abell conducted a study of his researches over the last 40 years, and it can be concluded that the application of LC can increase engagement, reasoning, and students' comprehension in science classes (Marek, 2008). LC also enriches learning and provides real scientific experience (Turkmen, 2006).

In the learning process, evaluation plays an important role. The success of the learning process can be known by evaluation. According to Arikunto (2004) evaluation is an activity to collect the information of doing works, then the information is used to determine the proper alternative in taking decision. Evaluation of the learning process aims to provide data, information and recommendation for policy makers to decide whether they will continue, repair or replace the learning process. Data evaluation is needed to comprehension assessment. According to Jihad and Abdul Haris (2008), assessment of learning process was developed based on a number of principles, namely: a comprehensive, continuous, indicator achievement oriented and in accordance with the learning experience. Selection of techniques and the development of assessment instruments must be carried out correctly, so that it can describe considered complete and precise aspects.

Performance assessment is very appropriate to be applied in physical chemistry lab. Performance assessment is carried out by observing the activity of working. The performance assessment is proper to assess to laboratory activities (Jihad and Abdul Haris, 2008). The developed assessment instruments can be either mastery of competences assessment scale or check-list.

Self assessment is an self-evaluation regarding to reflection, work quality and learning evaluation, achievement, strengths and weaknesses of working, and improvement. Evaluation can be used to cognitive,

and affective and psychomotor measurement. Self-assessment is a process of formative assessment during which students reflect on and evaluate the quality of their work and their learning, judge the degree to which they reflect explicitly stated goals or criteria, identify strengths and weaknesses in their work, and revise accordingly" (Andrade and Du, 2007). Many studies were conducted to know the effect of self assessment. Self assessment has positive influence on the development of metacognitive skills, determination of actions to improve the quality of work, a sense of responsibility, the development of critical thinking skills, and reduction of deviant behavior (Cooper, 2006; Cyboran, 2006; Ross, et.al., 2006) .

RESEARCH METHOD

The approach of the research was qualitative-descriptive. The aims of the research were to describe and learn the influence of the implementation of LC (5E), performance assessment and self assessment on physical chemistry experiment. Subject of the research was the students who take physical chemistry lab course in academic year 2014/2015.

Research was conducted on 6 chapters of physical chemistry lab course using LC (5E) model, and at the end of the lab work the student filled out self assessment, the final exam was performance assessment at each chapter of experiment.

Designs of activity on experiment of physical chemistry include:

1. Preparation of practical guide
Preparation of practical guidelines refers to the stages of LC (5E), starting with the introduction of contextual and applicable material, work procedures that accommodate the stage engagement, exploration, explanation, extension, and evaluation. The guides were prepared afterward the content was validated by experts.
2. Assistants briefing
Assistants briefing consists of a practical simulation, briefing on LC (5E) and lab materials. Hopefully, through the lab simulation, the assistants can be better in guiding the students. Briefing is incredibly needed retrace the assistants have never done the learning model of LC (5E) yet and in order to the assistants have comprehensive understanding of lab materials
3. The development of assessment instruments
Assessment and achievement instruments of the learning process were arranged based on the set indicators. Construct validation of instruments were

conducted by expert team, and corrected if there were still shortcomings. Process assessment instrument was such as student satisfaction questionnaires. Learning outcomes assessment instruments included the form of performance and self assessment.

Measurement aspects of student satisfaction in the questionnaire were the student's responses to: 1) lab manual, 2) lecturers activeness, 3) the competence of assistants, 4) assessment of performance, 5) self-assessment, 6) students interest and satisfaction of practical implementation.

The development of performance assessment instruments were adapted to the practice done. Each of the experiments has performance assessment instrument, which is the indicator instrument adjusted to the stages of experimental work, including work procedures, data collection, and data analysis. In the aspect of data analysis, it can be measured the students' understanding of trial materials (cognitive). Performance assessment instrument also has been completed with rubric assessment.

For the self assessment instrument, the measured aspects are: 1) understanding of experiment objective, 2) understanding of experiment principle, 3) skill of using the experiment equipments, 4) understanding of chemicals treatments, 5) understanding of work procedures, 6) skill of experiment observation, 7) skill of data collecting, 8) ability to connect the experiment data and theory, 9) skill of conclusion making.

4. Implementation of experiment

There were 6 chapters of experiments, that is: 1) thermochemistry, 2) critical micelle concentration and gelatin enthalphy, 3) isotherm adsorbs, 4) viscosity and flow activation energy, 5) solubility as a function of temperature, 6) kinetics of fenofalein decomposition in alkaline solution.

The experiment was conducted by implementing the LC (5E). After pretest, the assistants provided an introduction and contextual questions to generate students' interest and curiosity (*engagement stage*). The students did the experiment by their self and found the answers of the main question of the experiment. The assistants monitored the students work so as it does not deviate from the subjects and reminded the students if the did not do the proper procedures (*exploration stage*). The students' conducted the result clarification. The assistants completed and corrected if there were wrong concepts and procedures (*explanation stage*). The students returned to do lab activity in the new situation to deepen their concepts and skills (extension stage). In the end of the experiment activity evaluation was done, evaluation

of implementation of the lab activity was done by the students itself and reviewed by the assistants. The students conducted self evaluation regarding to their skills and understanding of the conducted experiment.

5. Experiment review

The aims of the experiment review were to evaluate and clarify all the conducted experiments. In review, the assistants explained the work procedures, errors in calculations and data analysis of the experiments.

6. Final examination

The final exam was designed by the students in the form of practical performance. Each student showed their performance on six chapters in the experiments.

RESULT AND DISCUSSION

Implementation of the experiment and assessment system received positive respond from the students. Student respond regarding to the practical guide were excellent. From the questionnaire filled out by the students, approximately 89% respondents considered that the practical guide of physical chemistry experiment was so interesting because of completed with the application and it helped the students to understand the conducted experiment. Generally, practical guide consists of objectives, basic theory, tools and materials, and the procedures of the experiment. Although the practical guide has described the conducting experiment, it cannot generate the students' interest. The presence of the practical guide which is adjusted to the LC (5E) stages made the students was more interested to study. The guide was started with the benefit, application of the experiment in daily life or in industry. The work procedures also accommodated the students to do experiment by their self classified the result and conducted the further experiment in the new situation to extend the concepts and skills.

Respond to the implementation of the experiment was excellent also, approximately 89% students felt satisfied about the implementation of the experiment. The students considered the experiment of physical chemistry were useful, applicative, and interesting. Achievement of the practical skills, understanding of the materials, and students satisfaction exceeded a minimum predetermined parameter. The summary of the research achievement is as follows:

No	Parameter	Target	achievement
1	The percentage of students competence in the practical skills (set completeness criteria Score 70)	70%	100% with the average score 85
2	The percentage of students competence in the understanding of materials (set completeness criteria Score 70)	70%	100% with the average score 89
3	The final students score	score $\geq B = 90\%$	score A = 100%
4	The average score of the students' satisfaction regarding to the learning implementation	80	81,5

LC (5E) can provide positive influence on the achievement of the competence, practical skills, and students' understanding caused by: 1) LC (5E) is initially designed to improve the quality of science learning, so that it is appropriate to subject which has scientific approach as if experiment, 2) Engagement stage, the students' interest and curiosity were generated to conducted experiment. Those were not found in the implementation of the usual used experiment. This stage is important because the learning process will not be effective without the student's interest and consciousness, 3) the interest and curiosity appearance can encourage the student to do the experiment actively to address the disequilibrium in cognitive structure, 4) The students were given chance to do experiment by themselves (under the lab assistants control) to seek the answer of the arises questions and explain the result. It can make the students are used to doing scientific activity which can train practical skills and understanding, 5) this stage is to clarify cognitive structure and students' skills, so that it can minimize the probability of misconception and improper performance. The students were given chance to implement cognitive structure and their skills

in the new situation, so that it can strengthen the students' understanding and practical skills.

The presence of self assessment in the end of experiments also help the students evaluating themselves ability. Through the self assessment, the assistants and lecturer will find the students achievements and difficulties, so that it can be addressed instantly (*evaluation stage on LC (5E)*). One hundred percent of the students considered that self assessment found self-evaluation. Frequently implementation of experiment was only oriented on experiment execution and less provided to evaluate themselves. It can help the students, assistants and lecturer to decide the skills and the unknown or not understood materials of the students. Self assessment data can be used to assistants and lecturers to review the skills and not understood materials of the students. *Self assessment* did not belong to students' evaluation aspects but it was evaluation materials of students' achievements, so that the students' can evaluate learning achievements objectively.

Performance assessment system is also considered more favorable for the students. One hundred percent of the students thought the performance assessment is more beneficial and not incriminating. This is due to the student performance assessment assessed based on the student learning experience.

CONCLUSION

Based on the research, implementation of learning cycle 5E, performance assessment, and self assessment on physical chemistry experiment provided positive influence and is highly possible to be implemented in other practical subjects.

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