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Skill Development on Designing Chemistry Learning

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Abstract. Developing the design of learning is one of the core competencies that must be mastered by teachers. One of the courses organized to develop the skills of designing learning is Teaching and Learning Strategy. The course equips students with analytical skills in selecting and developing learning strategies in the form of lesson plans. The developed lesson plan must be in accordance with the objectives and characteristics of the chemistry material in the school. Learning by using project based learning (PjBL) model can be applied to develop learning design skills. The purpose of the research is to describe the application and influence of PjBL to the skill of designing learning. The study used a descriptive approach with research subjects of Chemistry Education students of the fourth semester from academic year 2015/2016. The research instruments include course outline, hand out, project assessment sheets, achievement test, and self assessment. Lectures are conducted according to the stages in PjBL: start with the essential question, design a plan for the project, create a schedule, monitor the students and the progress of the project, assess the outcome. Students are given a project to produce a book containing chemistry lesson plan in senior high school. The research data shows that PjBL has a positive impact on the designing skills of learning. Students can analyze and choose learning strategies in designing chemistry learning. Students also give positive response to the application of PjBL.

INTRODUCTION

Since the issuance of Law on Teachers and Lecturers, teachers' professional demands are getting higher. Qualifications and competencies are the things should be possessed by teachers. It is the teacher's educational responsibility to prepare professional candidates for teachers. One of the factors affecting the quality of teacher candidate learning is attitudes and perceptions of the teaching profession[1]. Positive perceptions and attitudes can be developed through learning that gives a real picture of the teacher profession.

One of the competencies that must be possessed by Bachelor of Chemistry Education is mastering knowledge about model, approach, strategy, method, and instructional media, and its application in designing chemistry learning. Teaching and Learning Strategy subject (TLS) is a course that is held to support the competence.

The scope of the material in TLS is very broad and theoretical, for example there are dozens of learning models that need to be studied. Experience shows if students are only given lectures with conventional methods, students are less understanding and mastering the lecture materials. Therefore, students only study the theoretical material and are less able to apply in designing chemistry learning. Lectures are needed to facilitate students to analyze, select, and design a chemistry learning plan at school. One alternative solution is to implement project based learning (PjBL) in TLS lectures. This model is supposed to be able to facilitate students to achieve lecture objectives.

PjBL is a learning model that facilitates students to learn actively through learning by doing. PjBL makes the project as a core activity. PjBL facilitates students to apply the learned concepts[2]. Students are required to actively build knowledge through real work. Products that produced from PjBL come from issues that are weighty, relevant, real, and complex. The results of the AutoDesk Foundation study show that PjBL has the following characteristics: learners make decisions about a framework, the problems posed to learners, learners design the process to determine the solution, learners are collaboratively responsible for accessing and managing information, evaluation process continuously, learners regularly reflect on activities that have been executed, the final product will be evaluated qualitatively, the learning situation is tolerant to mistakes and changes[3].

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PjBL focuses on the key concepts and principles of a discipline, involving students in problem-solving and meaningful assignments, giving students the opportunity to work autonomously, constructing learning experiences, and ultimatly producing real-life products[4]. The learning steps (syntax) of PjBL developed by The George Lucas Educational Foundation include: start with the essential question, design a plan for the project, create a schedule, monitor the students and the progress of the project, assess the outcome, evaluate the experience. Many studies have been conducted to study the effect of PjBL application[5]. The application of PjBL has a positive influence, among others, on the development of attitudes, self-concept, habituation of environment-based learning, academic achievement, understanding of contextual knowledge, interest, and curiosity[6,7,8].

In the learning process, evaluation plays an important role. Neither it achieved nor not achieved the purpose of learning can only be known by the evaluation process. The selection of techniques and the development of assessment instruments should be carried out appropriately, so as to describe the complete and apropriate assessed aspects. In the assessment of the project there are at least 3 aspects to be considered, namely: the ability of project management, relevance, authenticity.

Self assessment is related to reflection, evaluation of work quality and learning, assessment of achievement, strength and weakness in work, and improvement. Self assessment can be used in higher education to help students learn more efficiently[9]. Self assessment has a positive effect on the development of metacognitive skills, the determination of action to improve the quality of work, the sense of responsibility, the development of critical thinking ability, and the reduction of behavioral deviation[10,11,12].

RESEARCH METHOD

The research used descriptive approach. The purpose of the research is to describe the application and influence of PjBL to the skill of designing the learning. The subjects of the study were Chemistry Education students, Islamic University of Indonesia in the fouth semester of the academic year 2015/2016.

Instruments used in the study consisted of research implementation instruments and data collection instruments. Instrument of research implementation covers course outline and hand out. Course outline is arranged based on PjBL syntax. The data collection instrument is developed based on the indicator set. Instrument construction validation is performed by colleagues. Instrument of data collecting in the form of student satisfaction questionnaire, lecturer observation sheet, project assessment, achievement test, and self assessment.

Project assessment consists of 3 aspects, namely planning, implementation, and product. Each of these aspects is further elaborated in the assessment indicator. In order project assessment to be objective, an assessment rubric can be used as a reference in the assessment. Self assessment is not included in the aspect of student assessment, but is the material of student achievement evaluation. So that students can objectively evaluate learning achievement. The learning achievement test is developed based on indicators of instructional design skills. The questionnaire was developed to find out the responses and the students' assessment on the quality of the learning process.

The learning is designed with 14 lectures. In addition to the lecturers' materials, the lectures are conducted stages design a plan for the project, create a schedule, monitor the students, the progress of the project. Students present the project results at the 7th and 14th meetings (assessment and evaluate stage).

The project conducted by students is creating the design of chemistry learning in senior high school using the model and learning method studied in TLS lecture. The project product is a book containing a collection of high school chemistry learning designs (lesson plan).

Data collection is done throughout the application of PjBL. Observation data, achievement tests, and project assessment are used to describe the application and influence of PjBL. The self assessment data is used as a comparison.

RESULT AND DISCUSSION

Learning begins by providing essential questions, questions that can lead to the assignment (start with essential question). Students are directed to the urgency of selecting learning strategies and developing the lesson plan. Students show high interest. Therefore, the question given is relevant to the teacher's task. This stage not only aims to lead students to projects that will be done, but also to generate interest. This stage is important because the learning process is not effective without the interest of the students. Briefing and generating interest can be effective if the question is real, weighted, and relevant to the student's needs.

Furthermore, go into the design a plan for the project. Students collect information related to the focus of the project which is making the design of high school chemistry learning. This stage trains students to communicate effectively and courteously. Students practice to appreciate differences and integrate opinions in making project designs. Next stage, create a schedule, lecturers and students collaborate to arrange an activity schedule to complete the project. Lecturers and students determine the timing of project progress reporting, collection, and project presentation.

Lecturers monitor and facilitate student activities in completing the project (monitor the students and the progress of the project). Monitoring is conducted by students reporting to lecturers directly on schedules that have been agreed at the beginning. Student shows progress of project activity to lecturer periodically. Monitoring increases the intensity of lecturer-student communication. If misconception arises, it can be known and immediately followed up by the lecturer. Lecturers can know the level of understanding, concepts that have not mastered, and difficulties faced by students in project work.

After completing the project, students conducted the assessment of the outcome. Assessment is conducted to measure learning achievement, play a role in evaluating progress, and provide feedback on the level of understanding that students have achieved. Assessment of outcomes is an activity of analyzing the products of the projects that have been run. At the 7th and 14th meetings, the students presented the project. Classes become very dynamic, because each student provides comments, feedback, questions on other group projects. The student's analytical skills arise when assessing the accuracy of designs made by other groups.

At the end of the learning process, reflection of the activity and the results of the project has been conducted (evaluate the experiences). Students express experience in project completion. Lecturers and students collaboratively evaluate the learning experience. Students show a positive attitude when evaluating learning. Students are happy to have their own book containing the chemistry lesson plan in school. During lectures as many as 14 meetings are relatively not appearing saturation, unlike conventional lectures.

In general the class condition is very conducive. Students actively deepen the understanding to be able to complete the project. The intensity of the discussions between the lecturers, as well as among the students increased significantly when compared with conventional lectures. Observations show that students are seen enjoying the way of learning through project work. All students showed an increase in activity. The complexity of the task, causing the project to be carried out together in groups.

Project products created by students can describe that students have been able to choose the strategy and design the learning according to the objectives and characteristics of each material. The average final grade of the student project is 85.2 (maximum score 100). At the end of the lecture is given a learning achievement test. Project assessments and achievement tests were developed based on aspects of instructional design skills according to Minister of National Education Regulation No. 16 of 2007. Aspects assessed include: 1) determining learning objectives, 2) determining learning experiences (learning strategies) as intended, 3) choosing learning materials, 4) organizing learning materials, 5) developing learning design components. The average value of student's final learning achievement is 80.3 (maximum score 100). The value of learning achievement achieved exceeds the target set by the Chemistry Education Department, which is 70.

The project product and final test show that the student has been able to make a chemistry lesson plan. The learning strategy is chosen according to the chemistry material characteristics of the school. The detailed design of the lesson explains the steps of learning and organizing the material. Table 1 shows the variation of student learning strategies that students selected in the product of the project.

At the end of the lecture the students fill out the questionnaire to find out the student's response to the quality of lecturing process. Questionnaires measure aspects of lecturer quality, PjBL effectiveness, and hand out quality. Description of student questionnaire scores can be seen in table 2. From the student questionnaire, it can be seen that students are satisfied and feel lectures with PjBL useful

Self assessment is used for reflection of lecturers. From the self assessment, it can be seen that students feel able to analyze the appropriate learning strategy used according to the characteristics of the material and can design the learning of chemistry.

The data obtained during the study show that PjBL develops learning designing skills. Johann et.al shows that 90% of students who follow the learning process with PjBL implementation are confident and optimistic to implement PjBL in the world of work and can improve their academic achievement[13]. Although the application of PjBL is relatively easy to implement, it needs proper handling so that PJBL can run well and have a positive impact on students. Lecturers should be good facilitators in the application of PjBL[14]. Stage of start with essensial question, requires carefulness of lecturers to provide questions that can direct thinking and generate student interest. If the number of students is large enough in one class, it becomes a challenge in applying the design stage plan for

the project, create a schedule, and monitor the students and the progress of the project. Because, there will be many groups that need to be monitored its performance by lecturers.

TABLE 1. Variation of learning strategies in project product

Topic	Learning Strategy
Introduction to chemistry	Mind map
Atomic structure	Jigsaw II
Chemical elementary laws	Problem posing
Stoichiometry	TGT
Solutions	CTL
Hydrocarbons	Make a match
Thermochemistry	TAI
Chemical kinetics	Problem solving
Chemical equilibrium	STAD
Buffer	NHT
Solubility	TPS
Colloid	PjBL
Chemical elements	GI, CIRC, Coop Coop

TABLE 2. Description of students's questionnaire data

Aspecs	Indicator	Average Score (Maximum Score: 4)
Lecturer Ability	Mastery of material	3.8
	Classroom management	3.6
PjBL Effectiveness	Influence on lecture achievement	3.6
	Acceptability of implementation	3.7
Lectures Material	Breadth and contemporary	3.5
	Suitability with lecture objective	3.7
Hand out Quality	Material clarity	3.5
	Suitability of contents	3.8
	Utilization	3.5

CONCLUSION

PjBL has a positive impact on the development of learning design skills. Lectures are conducted according to the stages in PjBL: start with the essential question, design a plan for the project, create a schedule, monitor the students and the progress of the project, and assess the outcome. Students are given a project to produce a book containing chemistry lesson plan in senior high school. The average value of a student project is 85.2. The average score of student achievement is 80.3. The average score of learning achievement exceeds the target set by the Chemistry Education Department, which is 70. Students assume that PjBL is easy to implement, not burdensome, feasible to apply, develops learning design skills. From the self assessment can be seen that students can analyze the appropriate learning strategies used according to the characteristics of the material and can design the learning of chemistry.

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REFERENCES

1. Ali Muhson, Jurnal Kependidikan. Letters **38**, 77-92 (2008).
2. S. S. Sumarti, E. Cahyono, A. Munafiah, IOSR-JRME. Letters **5**, 1-5 (2015).

3. K. Merdekawati, “The implementation of project based learning to improve the competences of teacher candidates”, Proceeding of the 3rd International Conference on Education (TIIKM Education 2017), pp.58-63.
4. G.E. Okudan and S. E. Rzasa, J. Technovation. Letters **26**, 195-210 (2006).
5. The George Lucas Educational Foundation, “Instructional module project based learning”, http://www.edutopia.org/modules/PBL/whatpbl.php (2005).
6. F. Alacapinar, EJER. Letters **32**, 17-34 (2008).
7. N. Kalayci, Education and Science. Letters **33**, 85-105(2008).
8. E. Erdem, WASJ. Letters **17**, 764-769 (2012).
9. E. Amo and F.Jareno, JOIS. Letters **18**, 41-47(2011).
10. D. Cooper, Orbit. Letters **36**, 20-23 (2006).
11. V. Cyboran, AEQ. Letters **10**, 183-186 (2006).
12. J. A. Ross, A. H. Gray, C. Rolheiser, Educational Assessment. Letters **8**, 43-58 (2010).
13. Johann,TM., H. Koch, S. Chlosta., & H. Klandt, Journal of Asia Entrepreneurship and Sustainability. Letters **2**, 1-16 (2006).
14. M. Kubiatko and I. Vaculova, EEST. Letters **3**, 65-74 (2011).