THE IMPROVEMENT OF STUDENTS' LEARNING OUTCOME WITH THE IMPLEMENTATION OF PROBLEM-BASED EXPERIMENT MODEL OF ELECTRICAL CIRCUITSON SUBJECT OF DIRECT CURRENT

Sehat Simatupang, Togi Tampubolon, Mariati Purnama Simanjuntak

State University of Medan
E-mail : sitoropan@gmail.com

Abstract

The problem faced in university is that the experiment process in physics laboratory still to be verified. To overcome this problem, it was developed problem-based learning model in Electrical Circuits Experiment which aimed to improve student learning outcomes in cognition domain. The study was conducted with research and development method. This study was conducted in the physics laboratory of FPMIPA Universitas Negeri Medan.The output were a set of problem-based learning, experiment tools and learning models of Experimental Electrical Circuits based on problem that could improve learning outcomes in cognition domain. Results of learning modeldevelopment of Experimental Electrical Circuits based on problem in this study is still in limited testing phas.

Keywords : learning model based on problem, experimental electrical circuits, cognition

A. INTRODUCTION

The improvement of education qualityis one of the national development program. All educational institutions, ranging from primary education to higher education, seeks to improve the education quality in accordance with their areas. Public demands on the education quality is atop priority that must be fulfilled, especiallyin the era of globalization. Faculty of MIPA (FMIPA) Universitas Negeri Medan (Unimed) as an institution which creates science (MIPA) teacher both primary and secondary level have made various efforts to improve the education quality of teacher candidate. Efforts have been undertaken by Unimed were; (1) increasing inquantity and type of laboratory equipment, (2) curriculum development, and (3) improving the quality of lecturer and technician/supervisor. Experimental Electrical Circuits includes as one of main course required to all student in department of physics, both education and non-education study program FMIPA Unimed.

After attending the lecture of Experimental Electrical Circuits it was expected that students could possess the concepts of physical electrical circuits and were able to apply it in daily life and technology. However, the efforts that have been made have not shown that the maximum results. It was demonstrated through observation result against the lecture performance of Experimental Electrical Circuits in Physics Education study program FMIPA Unimed, as follows: (1) Lecturer stated that the students' ability to possess the concepts of physics on Experimental Electrical Circuits was still low, but this course is one of the subjects that compulsory for all students majoring in physics and physics education. This wasshown by the average value of students in this course was C (70-79). (2) Lecturer also stated that the students' ability to apply the concepts of physics on Electric Circuits was still low. (3) Lectureof Experimental Electrical Circuits was performed in the laboratory to test the theory (verification) using a very detailed practical guidance.

Student competency were low in mastering and applying the concepts of physics, due to the students were weakly equipped with the necessary skills to be able to possess and apply the concept of physics such as skill of problem-solving, thinking and reasoning. Lack of debriefing those abilities could be seen from the learning process on Experimental Electrical Circuits which more dominant using the practical guide with highly detailed resulting the ineffective learning because students acquired knowledge of physics which more proving theories that already exists than trainingthem to solve problems related with the concepts of electricity in daily life. The lecturer recognized that this learning process was less able to train students to construct their own knowledge. As the result, students did not have the necessary skills to solve problems and were not able to apply what they have learned in daily life.

Unal & Özdemir (2013) and Heller & Heller (1999) warns that the step in formula laboratory (a verification guide) was less to provide the opportunities to process information deeply and the main concern of students were only the completion of practical tasks.

To improve the ability of students in mastering the concepts of physics, it was necessary to implement learning that could equip the students withproblem-solving ability in mastering and applying the conceptsof physics. One of learning model that could be used was aproblem-based learning. Problem based learning model was one model that forms the students to do problem solving creatively, actively and appreciate the diversity that arises during the process of solving problemsin other words the model of problem-based learning was a learning model that uses real-world problems as a context for students to learn about problem-solving skills to acquire knowledge and essential concepts.

Based on physics learning conditions described above then made efforts to implement the learning of Experimental Electrical Circuits that could improve the students'learning outcomes. The problem-based learning of Experimental Electrical Circuits was expected to improve the ability of students in mastering the concepts of physics, doing practical skills, and have a scientific attitude in doing experiment.

The study objective was to reveal the effectiveness ofthe problem-based learning of Experimental Electrical Circuits against toimprovement of students'learning outcomes. Results ofthis studycould be usefulto improvethe quality of learning on Experimental Electrical Circuits in the department of physics FMIPA Unimed.

B. RESEARCH METHOD

Research method used was research & development through 4-D steps, namely: definition, designing, development and dissemination (Thiagarajan, *etal*., 1974). This study developed problem-based of Experimental Electrical Circuits that couldimprove learning outcomesin the cognitive domain.

The phase of definition was done by collecting various information related to the product being developed. The collection of this information was done with a preliminary study through literature and field studies. The results obtained in the study of literature and field were used as a material for designing the initial product in the form of problem-based learning model for Experimental Electrical Circuits that could improve cognition and learning tools to support model developed. The phase of development was done through expert validation, limitation testing and large-scale trials. For the purposes of expert assessment it was prepared a rubric to assess and provide input to the test items which tested. The development draft of problem-based learning model for Experimental Electrical Circuitswhich have been designedthen validated by three experts (lecturers). Three lecturers chosen as experts have expertise in the sector of Experimental Electrical Circuits and learning. Inputs which given by expert used to enhance the learning model development draft of Experimental Electrical Circuits.

The phase of development was done the limitation testing after instruments have been validated and revised based on expert advice. Population in the study of limited scale trialwas allstudents takingthe course of Experimental Electrical Circuits Universitas Negeri Medan. Subject inlimited trials werestudent who will be a physics teacher candidatein Universitas Negeri Medan which consisting of one class. This research method waspre-experimental withone group pretest-posttest design.

The development of problem-based learning model was tested on a larger scale. The research population on large-scale trial was all student who will be a physics teacher candidate in Universitas Negeri Medan. Sample in this study consisted of two groups: the experiment group by applying problem-based learning model and control group with conventional learning. Method used in large-scale trial was quasi-experimental with pretest-posttest control group design.

The phase of dissemination in this study conducted at other universities outside of Universitas Negeri Medan in North Sumatra. The end product of this study and development was problem-based learning model of Experimental Electrical Circuits which has been tested could improve the cognition students.

The results of study on development of problem-based learning model of Experimental Electrical Circuitswas still in the phase of definition, design and development. Development was still up to the limited trial. The phase of definition has been performed by literature and field study. At the phase of design has made learningtools with the instruments and the phase of development has validated the instruments to experts, trial the instrument and implement the model which developed at the limited trial phase.

C. RESULT AND DISCUSSION

Analysis of necessity was performed through preliminary study in Universitas Negeri Medan. Preliminary studies was performed with the literature and field studies. Through literature studyhas beencarried outan analysis of physics teacher competence and the roleof Experimental Electrical Circuits lecture, cognition, theories and research findings. Field study performed through observation, interviews, and tests. Through observation and interviews could be analyzed the Experimental Electrical Circuits that already have been carried out and learning facilities available.

Based on observations in the field, the learning processof Experimental Electrical Circuits in the classroom tend to do lab work using practical handbook that was verified withthe tools and materials already available in the lab table. Students was not also faced with problems relating tothe material being studied, where as the material in the lecture of Experimental Electrical Circuits is very closely related to the problems in daily life. With this lecture, students were poorly trained skills because students were not faced with problems that require further investigation through experiment. Students were not trained to makea hypothesis before doing further experiments, students were not trained to design experiments in accordance with theideas andcreations respectively. Students were not also trained to select and use tools in which they must choose before.

The phase of definition was done by (1) Creating a learning management guidelines; (2) Designing syllabus/RPP on problem-based; (3) Creating LKM on problem-based; (4) Construct a set of test device, such as: cognition test on the topic Direct Current and observation guidelines. Construct cognitiontestson the topic of Direct Current using a reference indicator of cognition that has been previously defined. Making the student worksheet (LKM) on the principal concepts of Direct Current topic, namely : series and parallel circuit; Open circuit; Short circuit; Loop Analysis and Electricity Power and Transient symptoms. The step on students worksheet are: write the purpose of the experiment; presents a problemindaily life; hypothesize; write tools and materials to be used; determines theobserved variables; explain the experiment step, createdrawing plan; write observationsresult in the form of table; responsethe analysis questions; predictand make inferences.

The indicatorsof cognitionin this study were: remembering, understanding, applying, analyzing, evaluating, andcreating(Anderson &Krathwohl, 2001). Based on the indicatorsandproblem-basedlearning model, developed the test in the form ofmultiple-choicewithfiveoptions, totaling 26 itemson the topic ofDirect Current.

Aftertestsof cognitionskillsare developed then validatedbythree expertswhoare competentin their fields. Based on assessment of the experts could be stated that in generaltests of cognitionin terms o fmaterial, construction, and language have met the criteria as a test that measures learning out comes in the cognition domain. Based oninput from the assessment of expert then performed the improvement against the test item. Recapitulation ofthe expert assessment result against to cognitive test items which has been developedcould be seen in Table1.

Table 1. Summary of Cognitive Test Validity Result

No Statement	Comment
1	*option* less homogen
2	The sentence of question should use a general term
3-5	Fix the sentence of question
16	Wrong answer key
23	The cheat should be increased
25	Wrong answer key

Early forms of cognition tests on lecture of Direct Current consisting of 26 questions. Before the test used, the test was tested in advance to determine the validity, reliability, level of difficulty, and level of distinguish of the test. Test analysis result using the program Anates version 4.0.5. Based onthe results ofthis analysis, a total of 26 items for cognitive testd eveloped for lecture of Direct Current, there were 25 items that valid and one item was invalid. The value of Alfa Cronbach for reliability tests on this lecture was 0.91, which isincluded as very high criteria.

Limited trial was performed in Universitas Negeri Medan with total sample was 28 students who taken the course of Experimental Electrical Circuit. This research method was pre-experimental with one group pretest-posttest design. The research design is as follows:

O X O

Note : O = Pretest – Posttest in experiment class

X= Problem-based learning

The improvement of student cognition showed in percentage of gain normalized scores (N-gain). The average score of pretest, posttest and % N-gain cognition in Direct Current were shown in Table 3.According to Table 2 shown that % N-gain cognition in Direct Current topics was 32% in middle category. Based on table 3 it could be seen that the application of learning models of Experimental Electrical Circuit could improve students' cognition.

Table 3. Comparison Average Score of Pretest, Posttest and %N-gain category

Course	Average Score of Pretest	Average Score of Posttest	N-*gain* (%)	Category
Direct Current	4,86	11,25	31	medium

Increasing of % N-gain cognition described based on indicators of each component, including considering (C1), understanding (C2), applying (C3), analyzing (C4), evaluating (C5) and creating (C6). Forthe course of Direct Current,% N-gain C1, C2, C3, C4, C5 and C6 respectively was 52%, 35%, 43%, 21%, 15% and 17%.

This shows that increasing of % N-gain indicators for cognition component considering (C1), understanding (C2), and applying (C3), including medium category, while in componentanalyzing (C4), evaluating (C5) andcreating (C6) in the low category. Comparison of % N-gain cognition shown in Figure1.

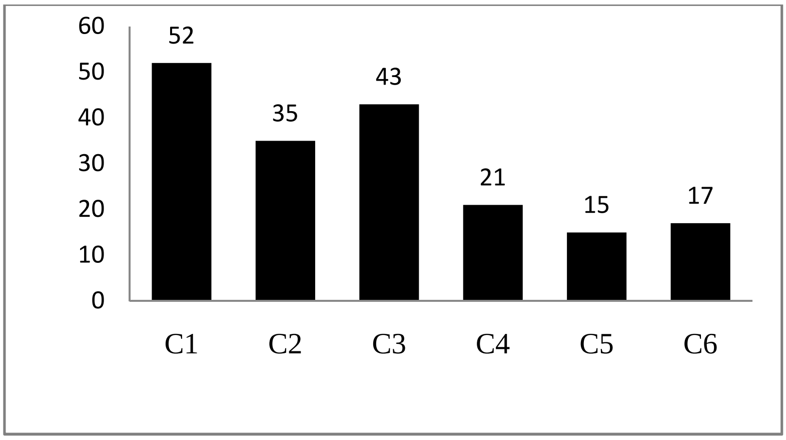

Figure 1. Comparison of N-gain cognition based on indicator

Increasing of student cognition was in medium category. However, if it was observed the increasing of student cognition per indicator, there was difference in category. For indicator of considering (C1), understanding (C2), and applying (C3), including the medium category, while in component analyzing(C4), evaluating (C5) and creating (C6) in the low category. The percentage N-gain ofstudent cognition for indicator C1-C3 was higher than indicator C4-C6. It was shown that the activity to analyze, evaluate and create were more difficult when compared with the activity to remember, understand and apply.

From all cognition indicator that could be expressed in Experimental Electrical Circuit based on experiment, it turns out the students' ability to analyze, evaluate and create include in low category. This was probably due to students not having prior knowledge in the subject which will be discussed. Ability to analyze problems and construct solutions, and examine solutions were the part of the problem-solving ability. Mastery of concepts, in this case the student cognition could be improved by group problem solving activities (Bormann, 2012). This was supported by Hofstein&Mamlok-Naaman (2007) states that doing experiment in laboratory was intended to improve the mastery of concepts in science and its applications; problem-solving skills and scientific skills; scientific thinking habits; understand how science and scientists are working; and foster interest and motivation.

The research resultwas consistent with findings previously reported that through problem-based learning could improve the mastery of concepts (Duch et al., 2001; Akinoglu&Tandogan, 2007). At this stage of the problem orientation, students in the group were given the problem, giving this problem will arouse curiosity and motivated her students to be able to solve the problem so that controllingof concept will also increase (Fogarty, 1997). According to Tan (2003), the evidence suggested that problem-based learning could improve the transfer concepts to new situation, concept integration, intrinsic interest in learning, and learning skills. Meanwhile, Mitchell (in Tan, 2003) revealed that the problem-based learning could help student to construct knowledge and reasoning skills in comparison to traditional learning. The process of constructing knowledge through social interaction with other friends was potential to enrich the intellectual development of students (Ibrahim and Nur, 2004).

D. CONCLUSIONS

Conclusion obtained based on the results of research that has been done was as follows:

1. It has been designed problem-based learning model of Experimental Electrical Circuit to improve students' cognition. The cognition indicator developed was remembering, understanding, applying, analyzing, evaluating and creating.
2. Based on the limited test results showed that the model problem-based on Experimental Electrical Circuit could improve the learning outcomes in medium category.

ACKNOWLEDGEMENTS

We want to thank to Directorate of Higher Education who has given the financial for supporting the implementation of competitive research grant with letter of agreement 016A/UN33.8/KU/2015.

REFERENCES

[1] Akınoglu, O. dan Tandogan, R.O. Effects of Problem-Based Active Learning in Science Education on Students' Academic Achievement, Attitude and Concept Learning. *Eurasia Journal of Mathematics, Science & Technologi Educatio. 2007. Februari: 3 (1), 71-81.*

[2] Anderson, L.W. & Krathwol, D.R. (eds). *A Taxonomy for Learning Teaching and Assessing*. A Revision of Bloom's Taxonomy of Educational Objectives. New York: Addison Wesley Longman, Inc, 2001.

[3] Duch, B. J., Groh, S. E., and Allen., D. E. *The Power of Problem-based Learning*. Virginia: Stylus Publishing, LLC, 2001.

[4] Fogarty, R. *Problem-Based Learning and Multiple Intelligences Classroom*, Melbourne: Hawker Brownlow Education, 1997.

[5] Heller, K., & Heller, P. *Problem-Solving Labs*. Introductory Physics I Mechanics. Cooperative Group problem-solving in physics, 1999.

[6] Hofstein, A.& Mamlok-Naaman, R. The Laboratory in Science Education: The State of The Art. *Journal of Chemistry Education Research and Oractice*, 2007; 8(2), 105-107.

[7] Ibrahim, M. dan Nur, M. *Pengajaran Berbasis Masalah*, Surabaya: University Press, 2004.

[8] Tan, O. S. (2003). *Problem-based Learning Innovation*. Singapore: Thomson Learning, 2003.

[9] Thiagarajan, S., Semmel, D. S. & Semmel, M. *Instructional Development for Training Teachers of Exceptional Children*. Source Book. Bloominton: Center for Innovation on Teaching the Handicapped, 1974.

[10] Ünal, C. &Özdemir, Ö. F. A physics laboratory course designed using problem-based learning for prospective physics teachers. *European Journal of Science and Mathematics Education, 2013;* 1(1) 29-33.