Design and development of model-eliciting activity in energy and electrical power topics

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Abstract. The purpose of this research is to design and develop the model eliciting activity in the physics course on energy and electric power topic for students of electrical engineering. The method used in this research is Design and Development Research (DDR). This research was carried out in electrical engineering study program in one of private Universities in Lampung. This research consists of three phases of design and development research: 1) identify the problem, 2) describe the objectives, 3) design & develop the artifact. The result obtained in this research is the model eliciting activity design which consists of learning units based on model eliciting activity at the topic of energy and electric power to improve conceptual understanding students.

1. Introduction

In the 21st century there are ten skills that must be taught to the students. The skills include 1) creativity and innovation, 2) critical thinking, problem solving, decision making, (3) learning to learn, metacognition, 5) collaboration, 6) information literacy, 7) ICT literacy, 8) citizenship-local and global, 9) life and career, 10) personal and social responsibility-including cultural awareness and competence [1]. It is important for the students to have 21st century skills to be successful in the ever-changing job market [2]. Based on the Global Competitive Index of 2014-2015 Indonesia is ranked 37 out of 144 countries, in 2016-2017 Indonesia is ranked 41 out of 138, 2017-2018 is ranked 36 out of 137. Indonesia's ranking has increased, but is still under the other ASEAN countries. This situation indicates that the mastery of the concept of science is still low.

The main issue of questions on science education is: "How to teach?" [3] and learning model is very useful to help the learning process. Learning model used is expected to enable students to be active. The use of appropriate learning models will also have an impact on students’ understanding of the concepts.

Model eliciting activity (MEAs) is a learning model that has the following steps: 1) Pre-reading as individual warm-up; 2) Hands-on demonstration that is students engaged in hands-on activities to explore concepts related to the topic; 3) A model to predict material is a multi-representation model for predicting [4]. MEAs are particularly useful for improving conceptual understanding and means for assessing problem-solving processes in the field of electrical engineering [5].

Research on previous MEAs has been applied to heat transfer topic in chemical engineering [6]. MEAs have not been applied in the field of electrical engineering. Therefore, further research is required.
in the field of electrical engineering and also on topics other than heat transfer. We are trying to design MEAs on energy and electrical power topic to be applied to electrical engineering.

The topic of energy and electrical power is part of the basic physics course. The topic of energy and electric power is essential to study because technological developments should also be accompanied by energy savings. Physics is an important but difficult course to understand. Because of that, a way is needed to deliver physics so that student can understand the concepts of physics taught. Appropriate learning model is needed to improve the students’ mastery of the concepts.

2. Method
In this research we used DDR method. DDR has two types, namely: type one is a product and tool research, whereas DDR type two is a study of models consisting of development, validation, and use of models [7]. The research phase consists of three phases: 1) identify the problem, 2) describe the objectives, 3) design & develop the artefact [8]. This research will be conducted on electrical engineering students for basic physics course at one of Private University in Lampung.

![Design and Development Research (DDR) [8].](image)

Based on figure 1: Identify the problem is the initial phase in DDR study. At this stage a literature study consisting of syllabus, daily learning activities, and research of conceptual understanding. The next step, field study to see the problems that exist in the field, consists of observation of physics course model on electrical engineering used by Lecturer, and identify conceptual understanding students. Describe the objectives of designing and developing models eliciting activity in basic physics lectures on energy and electrical power topic to improve the students’ mastery of electrical engineering concepts. The purpose of course development is expected to improve the students’ mastery of electrical engineering concept. Design & develop the artefact is to design and develop Basic Physics course program. Artefact referred to in this stage is a lecture program of Basic Physics lecturing with student model eliciting activity of Electrical Engineering. In this third phase explains the design of model eliciting activity on the topic of energy and electrical power.

3. Result and discussion
This research uses design and development research (DDR) about model development. The results obtained from the phase of identifying problems are the syllabus used was still using conventional learning, the learning is still centered on the lecturer rather than the students, and the learning has never applied the model eliciting activity. Learning outcome is also not well structured. Students’ conceptual understanding is also low. This result is obtained based on observations that have been done. The results of the literature study show that MEAs can improve the students’ conceptual understanding student. Therefore, the purpose of this research is to design and develop the MEAs in the form of learning units that are expected to improve the students’ conceptual understanding.
Stages of design & develop the artefact is to design and design lecture models using MEAs. MEAs will be applied to electro engineering courses. MEAs are used because they are suitable for use in electrical engineering. MEAs involve simulating real-life problem-solving situations. The design of model eliciting activity on the topic of energy and electrical power can be seen in figure 2.

Model eliciting activity that has three steps: 1) Pre-reading as the individual warm-up, 2) Hands-on demonstration, 3) A model to predict material. Furthermore, MEAs are developed by adding the fourth step of presentation model and the use of multi representation in the first and fourth steps. The MEAs format consists of reading the article and completing readiness question, teacher lead a discussion on readiness questions and the problem statement (15 minutes), group work (40-70 minutes), group presentations (30-40 minutes), and revise solution and reflection [9].

The design of the MEAs model begins in part 1 Pre-reading as an individual warming-up. The article is presented in a multi-representation form consisting of representations of verbal diagrams, mathematical diagrams, and graphs on the topic of energy and electrical power. Students at the first stage read the article summary and answer asked questions individually. On the topic of energy and electric power on "saving electrical energy" in part 1, students individually read a summary of an article explaining how to save electricity. This pre-reading enables students to get information about energy saving. In addition to reading the article, students individually answer the questions presented in this section 1.

In part 2, Hands-on demonstrations, students in groups perform simulations and experiments. In part 2, students involved in Hands-on activities are embedded in the MEAs that allow them to explore concepts related to electrical energy. On the topic of energy and electrical power about "saving electrical energy" students make observations to find out the most appropriate method used to conserve electrical energy and to record the specifications of electronic devices that can help conserve electrical energy.

Figure 2. Design model-eliciting activity.
In part 3, a model to predict material, students in groups demonstrate the model. In this section students in groups make two notes of the model for "saving electrical energy" consisting of first notes such as the concept of electrical energy and a list of electronic device specifications that can save electrical energy and be represented in a multi-representation. Representation can help students in their reasoning solve problems [10]. The second note is a model of "saving electrical energy" that is useful to the community. In part 4, presentation model, the students with their group presented the model with verbal, mathematical, diagrams, and graphical representations. Students with their group members in part 4 present the model of "energy-saving energy".

4. Conclusion
Based on the phase of design and development research, which consists of identify the problem, describe the objectives, design and development the artefact, the model eliciting activity is obtained in electrical engineering for energy and electric power topic in the form of learning units. This design still needs to be developed further on other materials on basic physics topics or on other topics suitable for model eliciting activity (MEAs).

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