Optimization of Hybrid Learning Approach for Power Electronics Course Using Virtual Laboratory to Prepare Teachers in Industry 4.0

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Abstract Many challenges need to be addressed in facing the Industry 4.0 (I4.0), especially for teachers in schools or colleges. One of them is how to adapt a learning process with I4.0 where computers and technologies play an important role. A hybrid learning approach using a virtual laboratory could be the answer to this problem. Hybrid learning combines face-to-face learning, e-learning, virtual laboratory and practice in a laboratory. It could optimize the advantages of all methods and introduce educational technology to students. Furthermore, it will prepare the vocational teacher candidates in facing the I4.0. This paper focuses on developing, implementing and optimizing a power electronic course for vocational students with a hybrid learning approach using a virtual laboratory in Universitas Negeri Yogyakarta, Indonesia. The hybrid learning approach is validated by experts from electrical engineering education using an assessment method and analyzed by means statistically. The result shows that the hybrid learning approach by using virtual laboratory can be adopted for improving the analytical thinking skills in solving power electronics problems for students as a vocational teacher candidate.

Keywords hybrid learning approach, power electronics, e-learning, vocational teacher, industry 4.0

1 Introduction

Modern industry in the era of industrial revolution 4.0 (I4.0) has led to an increase in energy requirements, especially from renewable energy which is more efficient and offer better quality. Most of the energy that is used by the human being is electricity. To improve quality and efficiency of the electrical energy, many things can be done by converting energy. However, traditional converter systems are insufficient to increase the controlability, capacity, and the efficiency of power as well as efficiency for energy systems. For these reasons, current studies are now more focused on electronics switching. Power electronics consist of electronic switching principles to convert from Alternating Current (AC) to Direct Current (DC), DC to DC, AC to AC and DC to AC [1]. It is used in a wide range of applications such as motor controls, industrial applications, vehicle systems, electromechanical controls, and power systems integration of renewable energy resources. It become a subject course in the electrical engineering education curriculum for preparing teachers in electrical engineering fields. Power Electronic has abstract characteristics and complex mathematic calculations related to high frequencies and large currents & voltages. It requires a learning process that is integrated between the classroom, virtual laboratory, practice in laboratory, and e-learning to produce high analytical thinking skills.

The most common teaching approach used in higher education is a face-to-face lecture and it is known as the traditional teaching. But now, the lecture is described as passive teaching. This because it discourages students to think critically and construct their own learning. It just focuses on face-to-face interaction. It does not accommodate student opportunities for collaborative learning. Moreover, it does not give a chance for instructors to implement learning with analytical thinking skills. As a result, students may feel bored in a classroom with traditional teaching. They usually do not get motivated by the face-to-face classroom. In addition, they might think it will not bring any benefit for their future career. Therefore, they pay less attention to the lecturer. They do not care and do not participate in the class. As a result, it can cause behavioral problems for them.

Nowadays, the learning and teaching process on power electronics course have changed greatly. Science and technology have become digital and an integral part of the educational system in many countries.

Many institutional educations provide e-learning to support the learning process such as downloading lecture notes, learning web-based materials, attending web-based lectures and video lectures [2]. Many lecturers have investigated the scope of information and communication technologies in education [3], [4], [5]. On the other side, some lecturers have developed the virtual laboratory to give the practical skill for students and implemented in many subject areas such as Chemistry [6], Electronic Engineering [7], Robotics [8], Science [9] and Power Electronic [10] - [11]. The implementation of online learning and virtual laboratory give many advantages such as easy to use, reduce time, and allow students to perform several experiments within a limited time and plan carefully their future studies.

However, there are some problems with the way of teaching with e-learning or virtual laboratory, especially for the engineering subject like power electronics course. E-learning or virtual laboratory cannot satisfy the needs of the participants in the educational process. Skill development must be obtained by experiment rather than only computer simulation through e-learning or by the virtual laboratory. As a teacher candidate in vocational school, students must have analytical thinking skills to collect and analyze information, solve problems and make the best decision [12]. It can be improved by some learning methods such as causal thinking, creative thinking, knowledge seeking skill, systematic problem solving, and decision making. Consequently, teachers must integrate traditional teaching method, e-learning, virtual laboratory and practice in the laboratory to optimize the desired results.

Therefore, the author proposes an idea to optimize the power electronics learning process with the hybrid learning process using the virtual laboratory to improve analytical and rational thinking, the problem-solving, and decision-making skills for students, both in class and real life. Hybrid learning approach can be used to find the right mixed method for students from all the possibilities in learning offline or online and concerns about how to integrate face-to-face and online instructional as well as using the technology effectively. It can be a solution from the problems that exist in the power electronics course in Universitas Negeri Yogyakarta (UNY), Indonesia according to the quality and quantity of devices that are limited available in the laboratory and potential of danger if students make mistakes in arranging electronic circuits and cause damage to expensive equipment.

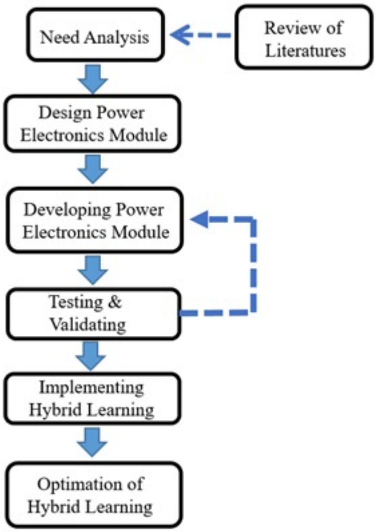

Figure 1.1: The procedure of research

2 Research Method

The research of optimization of hybrid learning approach with virtual laboratories in power electronics courses is carried out through a procedure as shown in Figure 1.1

The first step involves the research and information collecting for need analysis. It is conducted by literature reviews, classroom observations, and report preparation for state of the art. The second step is to design a Power Electronics module. The next step is developing the Power Electronics module that consists of manual, e-learning, virtual laboratory and laboratory module. The fourth step is validation the power electronics module to the electrical engineering education expert. The fifth step is implementing a hybrid learning approach in power electronics course with integrated into a virtual laboratory. Implementation of the hybrid learning approach carried out through classroom action research.

3 Result and Discussion

3.1 Hybrid Learning Approach

The hybrid learning approach using virtual laboratory on power electronics course is illustrated in Figure 1.2. The components of hybrid learning using a virtual laboratory on power electronics course are composed of fives elements. There are 1) student activities, 2) teacher activities, 3) hybrid learning, 4) assessment system, and 5) support system. Based on the judgment from the expert, hybrid learning approach applied in the power electronics course with virtual laboratory is highly recommended with average score 3,22. Average scores of 3,22 can be interpreted as good level, that means all experts give the good and a very good score in each aspect of the hybrid learning approach on power electronics course. They agree and give a good rate to the hybrid learning approach with confidence. Meaning, it can be implemented to improve analytical thinking skills and evaluation ability for the problem-solving in power electronics fields.

3.2 Implementation and Optimization

The implementation of hybrid learning using virtual laboratory on power electronics course is done in odd semester from September until December 2018. Based on data analysis in the field, the best results from the implementation of power electronics learning in the department of electrical engineering education of UNY are as follows:

a) Theory in the classroom: Power electronics learning starts from learning activity in the classroom with face-to-face method organized by the teacher. Face-to-face learning in the classroom is meant to provide basic provisions for electronic concept theory. From this learning, students are expected to have knowledge as a solution to solve some problems in power electronics fields. Active learning method is implemented in the classroom with face-to-face learning process.

b) Simulation using Virtual Laboratory: The next step is the simulation of power electronic circuits using a virtual laboratory. The use of a virtual laboratory is aimed so that students could understand

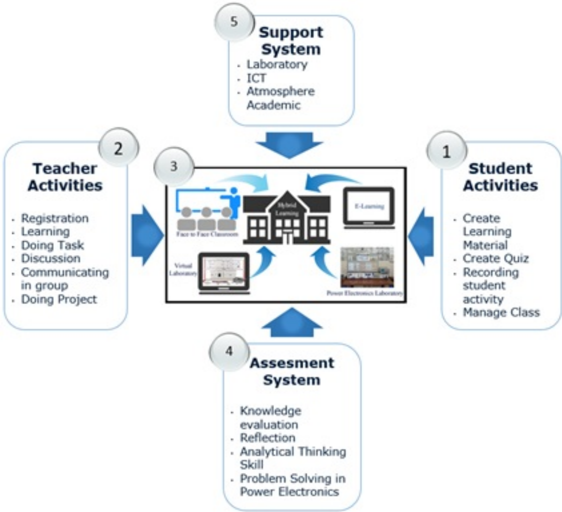

Figure 1.2: The hybrid learning approach using virtual laboratory

the procedures and do experiments in the real laboratory. Virtual learning is done by using power electronics computer-based learning media, PSIM and PSPICE software to help students understand the procedures of designing and analyzing the power electronic circuits.

c) Practice in real Laboratory: Laboratory activities begin with the introduction of tools and materials, measurements, and testing devices, identifying tools and practice materials, assembling power electronic circuits (Rectifiers, Controlled Rectifiers, AC Regulators, DC Chopper and Inverters), measurement process and analyzing input and output of the circuit. Student activities in the laboratory are designed by the project-based learning which has a chance for lecturer to give some assignments to the students, for example, designing power electronic circuits and solving real world problems.

d) Analysis: The next step is to analyze the results of laboratory activities in accordance with the theory that has been given. The analysis is carried out in the form of reports accompanied by data on the results of lab works and projects. Every student must make a laboratory activity report for every given job.

e) Presentation: The final step in hybrid learning is to present the results of the project that students are working on. Presentations are conducted in groups. It aims to train the students to work in a group.

4 Conclusions

Hybrid learning approach on power electronics course integrated a variety of learning methods. Traditional face-to-face learning in the classroom gives some basics knowledge for students. E-learning adds students' understanding of theory and self-paced learning. To improve analytical thinking skill and evaluation of ability to solve the problem in power electronics fields, face-to-face learning mix with e-learning, virtual laboratory and practice in the laboratory. A presentation can give the students experience to prepare, design, practice and present the theoretical concepts in class.

The optimization of the hybrid learning approach toward the power electronics course was done by integrating all of the resources related to conventional teaching, e-learning, virtual laboratory and practice in the laboratory. Active learning strategies are used to give students to participate in the classroom, e-learning, virtual laboratory and practice in the laboratory. This method can enhance the skill such as analytical skill, communication skill, and social skills. Student more interest and keep attention in class, e-learning, virtual laboratory and practice in the laboratory. Altogether this research shows that hybrid learning can be adopted for improving analytical thinking skill in solving power electronics problems for students as a vocational teacher candidate..

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