LABORATORY-SCALE TRAINING DEVICE FOR PROJECT-BASED LEARNING IN POWER SYSTEM EDUCATION

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1. Introduction

Laboratory-scale power system training device is being developed and evaluated towards active learning or Project-Based Learning (PBL) for Power System Engineering Education. These laboratory-scale training devices consists of the device and its management system which using a software program known as LabVIEW from National Instrument. These devices are being evaluated by conducting PBL program where allowing graduate and undergraduate students to conduct experiments related to power system by their selves. At the end of the program, students will answer some questionnaire and this questionnaire results are being used to evaluate the efficiency of these training devices in power system engineering education. Training devices developed also will cover on renewable energy topic where solid-state transformer module is being developed and its energy system management is being constructed using LabVIEW. To study in detail about the effectiveness of this module and PBL, T-Test analysis was done from questionnaire result. Analysis on the factor effecting the effectiveness of module in PBL such as level of study, major and experience related to power system was done. The target person on this evaluation was a group of third year degree students from Electrical Engineering Department and a group of first year master students from Electrical, Electronic and Mechanical Engineering Department students. Analysis on the results shown the effect of the given factors on PBL and the effectiveness of this training device in PBL.

2. Study Approach

In this study, quantitative study approach was used, which the step is shown in flowchart in Fig. 1.

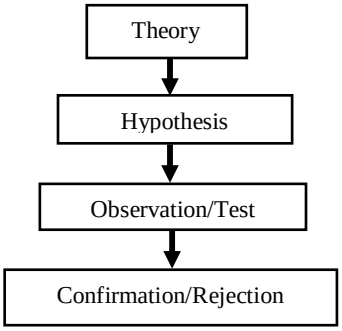

Fig. 1 Step in evaluation

In this study, module-type power system training device will be used in Power System Engineering Education for PBL, which is expected to lead an active learning and hands-on learning. To confirm this hypothesis, an evaluation of these devices was conduct by giving different background of graduate and undergraduate students conducting experiments related to power system. Students were divide into groups where each group need to do presentation about the theory before the experiment and presentation on results and discussions after the experiment.

Students need to refer to the manual given and do the experiments by their selves. However, teaching assistant is assigned for each group to support the students. This PBL program was held about one until two weeks. Students was evaluated based on their performance in class and a questionnaire that was given to them after the PBL program. A questionnaire also had been given to Electrical Engineering students in Japan and Malaysia to evaluate the effectiveness of PBL and their knowledge about PBL. By using these results, the hypothesis was evaluated.

3. Training Device Design

There are few types of power system training device such as commercial product power system training device, custom-made power system training device and hand-made power system training device. However, due to the big size and high in price, module-type power system training device was introduced. This device has smaller size and cheaper than other training device which make it suitable to be used for education in any learning institute.

Fig. 2 shows the image of module-type power system training device and Table 1 shows its specification.

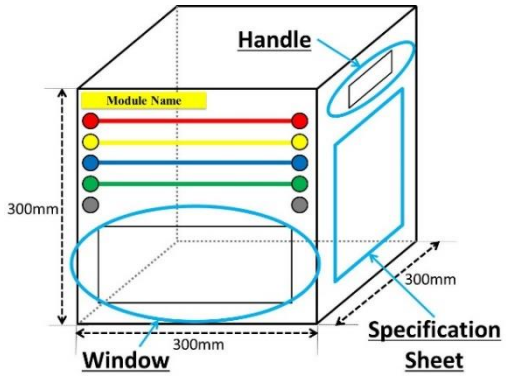

Fig. 2 Image for module-type training device

Table 1. TRAINING DEVICE SPECIFICATION

Design period	1 week to 1 month
Cost	300-5000 dollar
Weight	3-20 kg
Storage	Not required
Standard voltage	Three-phase, 200V
Maximum power	1 kW
Power Supply	Single-phase, 100V

Fig. 3 shows the design for DAB module. This module can be handled in manual or automatic where automatic means the DAB will work by itself and manual means the DAB will be control by LabVIEW.

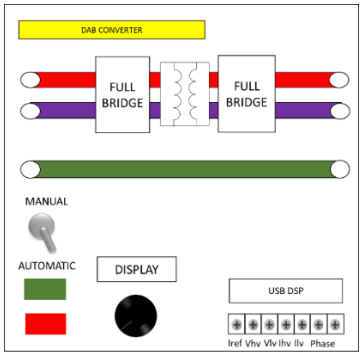

Fig. 3 DAB module design

4. LabVIEW Management

In this study, in order to visualize and mocking the real control and management system of power system such as supervisory control and data acquisition (SCADA), new control system that is adaptable to the modules was constructed by using LabVIEW. Adding LabVIEW function to the modules can increase students as they can see how the system works in real time without being disturbed to collect the data as LabVIEW will collect the data automatically when we switch on the program.

In this study, control and management system for solid-state transformer (SST) and dual active bridge (DAB) module was constructed. Fig. 4 shows the front panel for DAB control system. In this control system, current reference and phase shift is send and voltage, current is acquire from the module.

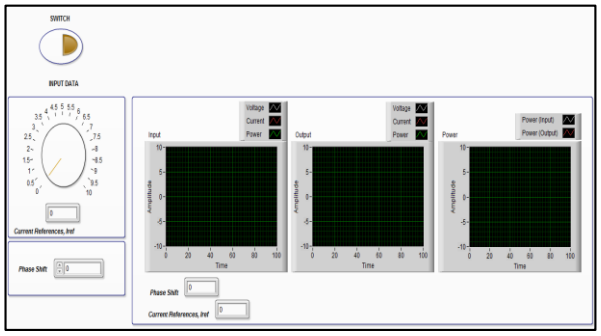

Fig. 4 LabVIEW front panel

5. Students Evaluation

Based on the questionnaire results, t-test was done and the effectiveness of PBL and training device was evaluated. Analysis was made on the factor that maybe affecting the effectiveness of PBL such as level of study, major and experience related to power system. Differences in answers from power system background students and others was evaluate.

6. Results and Discussions

Evaluation on PBL was conducted on 30 students from Electrical Engineering Department. Based on the questionnaire result, it shows that about 30% students said that they do not know about PBL. Students was asked what is the teaching method in their campus and about 80% of them answered that teacher-centered is being used.

PBL was conducted using modules and based on the questionnaire answered by the students, almost all of the students answered that module help them to understand more on the topic. Besides that, they also said that control and management using LabVIEW make it easier to understand the whole system. Graduate students from Electrical Engineering Department also said that this type of PBL somehow help them in their research as the experiment covered some topics that related to their research.

Based on t-test analysis, it also can be concluded that this device can be used as tools for PBL in power system and it is universal for any background of students.

7. Conclusions and Future Issues

Based on the students' evaluation, it shows that this type of training device do help the students to understand more about the topic learned.

Furthermore, by using LabVIEW program constructed, it also shows that control and management system could be constructed. This system will help the students to understand more about power system and will become more helpful when they become engineer and need to handle this type of control system

However, the whole control system for SST is not completed yet and evaluation is still not completed. In the future, this system need to be completed and evaluation on its efficiency need to be done. New training device that cover more on power system also need to be constructed.

Research Achievements

[1] Z. A. B Hanafi, G. Fujita, A. Rizqiawan: Module-type Power System Training Device for Project-Based Learning in Power System Education, ICEEIE 2017, ID 17101.

[2] Z. A. B Hanafi, G. Fujita, A. Rizqiawan: Implementation of Project-Based Learning using Module-type Power System Training Device in Electrical Engineering Education, The 11th South East Asian Technical University Consortium Symposium (SEATUC), Ho Chi Minh University, Vietnam.

[3] A. Z. B. Omar, K. P. Nguyen, Y. Honda, N. Matsumoto, Z. A. B Hanafi, A. Hoshikawa, G. Fujita: Towards Japan's Future EV-Friendly Highway Concept with In-motion Road-Embedded Wireless Chargers, JMEA-E20170619-1, Journal of Mechanics Engineering and Automation (JMEA), Volume 7, Number 5, 2017