Teaching and Learning in Engineering Based on Lab-Intensive

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Abstract

Nowadays, the achievements in engineering education are evaluated on outcome based education (OBE) system. This evolution is need specific approached on teaching method which based on lab intensive for engineering students. The comparison between the conventional with lab intensive approached will be evaluate to finding suitable teaching method for apply in engineering education. As a result, engineering education based on lab intensive is relevance and practical to apply in Malaysia’s university for support our industry need.

Keywords: Lab-intensive, Outcome based education (OBE)

1. Teaching and Learning Methods in Engineering

1.1 Conventional Method

Conventional approach or traditional teaching and learning methods is based more on process-oriented where teaching is carried out by providing information and disseminating knowledge in a centralized approach or in the classroom and lecture halls depending on the class syllabus and the teaching methods adopted by the lecturers [1].

1.2 Lab-Intensive Approach

Lab-Intensive approach is defined as a teaching and learning process which provides more practical sessions in the laboratory rather than activities in the lecture halls [2]. Several practical-based or lab-intensive approaches used by the University College of Engineering North Malaysia (KUKUM) or known as Universiti Malaysia Perlis (UniMAP) are based on the lab session and teaching factory as:

Laboratory session: Student involved with a small group (2-4 person per group) to do experiment. They make an experiment follow the instruction in lab module and lecturing before do it that experiment. The student must be submitting their lab report at the last lab session in the same day. The quality of the all lab report giving overall course work. The student also will be evaluating through practical test. At extra lab stage (khusus for 3rd year and final year student), their will make mini project as a assignment. These approached uses based on Problem-Based Learning (PBL).

Teaching Factory: Students involved in groups (average 5-6 people in a team) by performed same equipment or instruments which equivalent in industrial scale. Students will perform mini projects in groups using the facilities in the teaching factory. The mini project assigned will be similar to the problems solving process faced like manufacturing shop floor in industry.
2. Lab-Intensive Approach in Engineering Education

2.1 Outcome Based Education

The teaching and learning method of the engineering education in Malaysia is now more likely to produce graduates who are more thorough and responsible to the religion, social, economic and environment [3]. As early as 2003, the Faculty of Engineering (FKEJ), Universiti Kebangsaan Malaysia (UKM) has begun to change the pattern of a comprehensive education system from the conventional method of teaching-oriented process to Outcome Based Education (OBE) system. OBE is a learning process which focused on achieving specific results by focusing on student’s learning ability and understanding in order to build anything of quality issue [4].

According to Razali & Shukor 2006, UniMAP focused on teaching and learning activities which emphasize on lab-intensive activities, that is, one that requires the ability to manipulate physical artifacts or physical experiments [5]. Lab-Intensive is an engineering program for higher quality and there are several reasons as to why this approach is very important for the field of engineering, namely as:

- Students should be exposed to the practice oriented of engineering in addition to engineering science [6].
- Engineering graduates must be able to design and conduct experiments to better analyze and interpret data to become an engineer [7].
- Students should familiarize themselves with the engineering instruments and equipment in engineering practice in order to work in the industrial sector or further their studies.

2.2 Effectiveness of Lab Intensive Approach

Engineering programs, for example in UniMAP, are designed to produce more competent and efficient graduates or graduates of engineering who can be well received in the job market, along with the testimony given to the graduates which will ensure job opportunities in leading and multinational companies, or government linked company (GLC) especially in Malaysia. The effectiveness of this approach is proven through the acceptance of employment to UniMAP graduates by multinational companies such as Intel, Spansion, Altera, Motorola Technology and Silterra. Generally, all engineering programs in UniMAP are based on the implementation of lab-intensive training with the emphasis on hands-on approaches [8].

By implementing the lab-intensive approach, a more effective teaching and learning method can be applied to students thus ensuring a clearer understanding of the theory learned in lectures with practical sessions conducted in the laboratory session [9]. Although the time allocated for laboratory or practical session is more than theoretical lectures, this does not mean that students spend less time in lectures, compared with students who are undergoing conventional teaching and learning methods. Instead, it means more time is allocated to carry out practical sessions after the lectures. For comparison purposes, the 'contact hours' of teaching and learning method for students at technical universities (such as UniMAP) as opposed to conventional universities are as follows [9]: at the end of 4 years of study, a degree student at UniMAP will collect 3000 'contact hours' compared to 2400 hours for students in conventional universities. In other words, degree students at UniMAP allocate 17% (or 5 hours a week) more in the laboratory or lectures compared to students in conventional universities.

2.3 Program Educational Outcomes

UniMAP is one of the technical universities in Malaysia which applies the method of lab-intensive teaching and learning session to ensure that graduates can perform any task without further training in the industrial sector [10]. The objective of the establishment of these technical universities or called Malaysian Universities Network (MTUN) is to produce engineers who are capable, competent and able to perform any tasks, practically and theoretically required by the industry sector and job market demand. To achieve this, each UniMAP engineering program must fulfill the requirement of the Program Educational Outcomes (PEO) which outlines the performance expected from the graduates when they embarked in their profession. Program Outcomes (PO) is directly related to what can be achieved when students have completed their studies as in the area of knowledge, skills and behavioral. In general, all degree programs at UniMAP contain 11 PO including ethical values, professionalism, entrepreneurial knowledge, problem solving ability and a high technical competency.

2.4 Continuous Quality Improvement

Continuous Quality Improvement (CQI) includes comments or needs which will be evaluated
by the assessors for instance Engineering Accreditation Council Malaysia (EAC), external examiners, industrial advisors that must be considered in order to ensure that matters related to degree programs are evaluated and made improvement. Some examples of CQI are as recorded in Table 1 below [11]:

Table 1: Continuous Quality Improvement (CQI) for JKEES Degree Program

<table>
<thead>
<tr>
<th>No.</th>
<th>Comment</th>
<th>Comment by</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>The need to increase awareness of industry practices, and communication skills among students.</td>
<td>EAC assessor</td>
<td>Oral Presentation in JKEES courses.</td>
</tr>
<tr>
<td>2.</td>
<td>A balance between questions from the textbook and practical sessions (from the engineering practice) must be included in the final examination.</td>
<td>External assessor: Prof M A Rahman</td>
<td>All lecturers have been informed to improve the quality of examination questions</td>
</tr>
<tr>
<td>3.</td>
<td>Experiments in laboratory courses must be upgraded and updated within 3 years, especially those related to transmission lines, AC machines and Labview.</td>
<td>External assessor: Prof M A Rahman</td>
<td>Action will be taken by the Department.</td>
</tr>
<tr>
<td>4.</td>
<td>Students should be exposed to latest techniques in VLSI fabrication. Proposed technical visit to Intel.</td>
<td>Industry Advisor from Intel</td>
<td>Plan to conduct technical visit to Intel at the end of 2007.</td>
</tr>
</tbody>
</table>

3. Improvements proposal for lab-intensive approach.

a) Organize a more qualitative discussion forums with the industry with universities under MTUN and with the EAC and the Board of Engineers Malaysia (BEM) to ensure the quality of engineering graduates produced.

b) Making improvements on laboratory test where the said practical tests are carried out for 2 hours and they covered the entire subject of the study and adheres to the HEA01 set by the university. The laboratory tests must be assessed by external examiners to ensure the scoring quality and to improve the quality of test delivery.

c) Typically, the laboratory sessions which contribute 20% need to be reevaluated whereby students will be assessed and be given points immediately in the laboratory and if there are individuals whose reports should be sent, it must be submitted during the laboratory sessions itself. Instructors can also provide marks based on the achievement of students during practical sessions.

d) Generate laboratory-questions based on the Bloom’s Taxonomy which are related to the cognitive domain, psychomotor domain, affective and social domains. The Bloom Taxonomy depends on the level and degree of studies and the course is set depending on the results or CO for each subject.

e) Laboratory module need to test questions based on the outcomes obtained from each laboratory module carried out and the questions need to be provided for each laboratory module to test the students’ level of understanding when they performs all experiments in the laboratory session. The new approach will deliver more competent student rather than old version of laboratory manual which follow Standard Operating Procedure (SOP) and push button method.

f) Introducing the question bank system in which the theory test questions and laboratory questions can be easily obtained and accessed by instructors and students alike.

g) Early upload the hands out of laboratory modules to the student portal to enable early preparation for a more thorough understanding of the theories, methods and experimental techniques, as well as acquiring information or to trigger thinking
regarding the imminent results to be made available so that they can make observations and evaluation. This method can enhance their expertise in producing quality correct report writing.
h) Obtain comments and recommendations based on the CQI, Self Assessment Report (SAR) and Frequently Asked Questions (FAQ) from the employer that is provided by the employer when students undergo industrial training or those who served with the employer [12]. The CQI obtained can help improve the quality of graduates produced in line with the lab-intensive approach in the field of applied engineering.

4. Conclusion

Most technical universities under the idea MTUN or conventional universities have started to comprehensively change their education system from the pattern of teaching in conventional method to Outcome-Based Learning (OBE). OBE is a fundamental value that must be applied by the university that offers programs including engineering, while the lab-intensive is an OBE method that must be applied in all universities that offer engineering programs. In addition, lab-intensive approaches can provide a clearer understanding of the theory learned in lectures with practical sessions conducted in the laboratory and this method can accommodate the needs of the industrial sector today. CQI is a very important component in the measurement and evaluation of the effectiveness and continuous quality improvement of programs offered and this is in line with the method of bettering the existing lab-intensive approach. We hope that the improvements of lab-intensive approaches can be implemented in order to increase the quality of teaching and learning process in engineering fields. As a result, lab-intensive approach is very relevant as compared to conventional methods in the field of engineering today.

References