Assessment of Outcome-Based Electrical Engineering Curriculum, Faculty of Electrical and Electronic Engineering, UTHM

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Abstract

Program outcomes are the knowledge, skills, and abilities that students should be able to demonstrate at the end of a degree program. EAC requires that accredited engineering departments must define a set of program outcomes, and then put into place a continuous process to assess the achievement of these outcomes by their students. This assessment can be performed both at the whole program level, as well as at the individual course level. We produce several mechanisms for assessment namely: (1) assessment through course analysis of all students; (2) assessment through graduate exit survey; (3) assessment through the adequacy survey to the employers; (4) assessment through industrial training employer's survey. The results of these assessments will be used to improve the implementation of our Electrical Engineering programme. The paper outlines the assessment mechanism and the usage of the results in order to improve where necessary.

Keywords: OBE, programme learning outcomes, assessment, course analysis, exit survey, employers survey

Introduction

The basic tenets of Outcomes-based education (OBE) were propounded by William Spady (Spady,W. 1994; 1991; 1998) as being about shifting the focus of educational activity from *teaching to learning; skills to thinking; content to process; and teacher instruction to student demonstration.* University Tun Hussein Onn Malaysia, Johor (UTHM) had committed to embrace outcomes-based education for all academic programmes. The university is in fact working in compliance to the Washington Accord, where implementation of OBE is a must. This paper describes the assessment of the programme outcomes. Malaysian Engineering Accreditation Council(EAC), being the regulatory institution has revised its manual (EAC 2007) incorporating clearly the implementation of OBE approach to curriculum development including the assessment.

Implementation of OBE in the Faculty

Embracing OBE at Faculty Level

The faculty benefitted immensely by implementing the OBE curriculum. The culture that was developed among staff would greatly enhanced the prestige of the faculty. The commitment from the faculty members generated an ongoing continuous remedial process. Typically it happened when the outcomes missed the key performance criteria. This process of continuous quality improvement could be done at the appropriate time, at course and programme level. Total commitment from faculty members are required.

In order to determine the attainment of Programme Learning Outcome (PLO), two methods of assessment were applied, direct method and indirect method. The direct methods include the PLO survey of industrial training employers and the PLO adequacy survey to the employers. The indirect methods include the assessment through courses analysis, graduate exit survey and academic staff perception of student performance. Through these instruments the variability of assessment was achieved.

Defining Outcomes-Based Education

Spady (Tavner 2005) defined OBE as consisting of four principles: (i) clarity of focus, such that all *teaching and assessment, are geared towards generating the ability which the faculty specified the undergraduates to demonstrate*; (ii) expanded opportunity, which means *expanding the methods and number of times undergraduates get a chance to learn and demonstrate*" a particular outcome; (iii) high expectations, *which means avoiding bell-curve results*, all students should be able to achieve at the highest level; (iv) design down, meaning *designing the curriculum from the point at which the undergraduates are practicing engineering*

career. The curriculum design and teaching methodology really focuses on what our undergraduates can actually do after they are taught.

Clearly, OBE has much in common with Ralph Tyler's objectives model (Tavner 2005), which specifies that the curriculum for a programme should be developed from a statement of principles, the *objectives* and describes how students' behaviour should change due to the learning experience. Prideaux suggests a more rigorous interpretation of Tyler's original model be made, so that objectives may be described in other than behavioural terms. "*Higher order thinking, problem solving, and processes for acquiring values may be excluded because they cannot be simply stated in behavioural terms.*" (Tavner 2005). This put us back to the issue of assessment within the university system. Before, we submit a single mark for each student at the end of a semester. If we are to assess in an outcomes-based way, we would need to collect marks based on various level of achievement in each of the outcomes. If these multiple marks are then collapsed into a single final mark, we immediately lose the richness of that information. We are also faced with the problem of exactly how to amalgamate these marks: how do we weight the different outcomes, or the elaborations of the outcomes? Academicians had indeed try to produce such assessment techniques (Rozeha et. al. 2006, 2007).

Outcomes and Assesment

It is helpful to arrive at an operational definition of both outcomes and assessment. New Horizons for Learning (Anderson, 2000) produced the following definition, "*an operationally defined educational goal, usually a culminating activity, product, or performance that can be measured.*" Additionally, from New Horizons, assessment is defined as; " *...the process of observing learning; describing, collecting, recording, scoring, and interpreting information about a student's or one's own learning. When most useful, assessment is an episode in the learning process; part of reflection and autobiographical understanding of progress. Traditionally, student assessments are used to determine placement, promotion, graduation, or retention*"(Anderson, 2000). Outcomes assessment is more formative that summative, such that it should guide the process of designing a dynamic curriculum complete with the necessary documentation.

This paper discusses the assessment methods of the implementation of Outcome Based Education (OBE) in Faculty of Electrical and Electronic Engineering (FKEE), UTHM. The self-assessment report need to be done as part of the requirement by the EAC, for Bachelor of Electrical Engineering programmes accreditation. In order to determine the attainment of Programme Learning Outcome (PLO), two methods of assessment were applied, direct method and indirect method. The direct method includes the PLO survey of industrial training employers and the PLO adequacy survey by the employers. The indirect methods include the assessment through courses analysis, graduate exit survey and academic staff perception of student performance. Through these instruments the variability of assessment was achieved.

Assessment Methods of Programme Learning Outcome

PLOs are a set of descriptive outcomes which in simple phrase is stated as: "*statements that describe what the electrical engineering students are expected to know or able to do by the time of graduation*". These statements must accordingly be related to the skills, knowledge and behaviour that the student acquire throughout the programme. FKEE students, at the time of graduation are expected to attain those outcomes described in **Table 1.** PLO assessment will indicate the performance of the graduates after completing their four year programmes. For benchmarking purposes, the Key Performance Indicator (KPI) must be stated. The KPI is set as the average score for each PLO which must not be less than 60%. The score for the each course for each PLO also must be more than 60%. If for each course the score is less than 60% than it will be noted as need improvement. In order to demonstrate that the curriculum prepares the student for the PLO to be achieved, table relating the courses to the PLOs is utilised. The table illustrates the level of emphasis placed for a given PLO in a given course. In order to facilitate the assessment for PLO achievement, every academic staff is required to organise their course implementation according to the Course Learning Outcomes(CLO). The CLO for each course is stated in the syllabus document. The number of outcomes for each course is typically five, even though some might have more than five and some less than five. For each course, the outcomes are tabulated against the PLO and the taxonomy. Typical delivery of the course is through lectures, presentation and tutorial. Normally every academic staff will need to design their quizzes, tests, embedded mini project, assignments, and other assessment methods around this CLO. For the last two semesters (Semester 2 Session 07/08 and Semester 1 Session 08/09) every academic staff has had their opportunity to produce their own record of the quizzes, tests, embedded mini project, assignments, and other assessment methods which are valuable to the whole process of programme learning outcome assessment. The following are the assessment methods that were applied to assess the performance of each PLO.

Table 1: Programme Learning Outcomes for Bachelor of Electrical Engineering with honours

PLO 1	Acquired and able to apply knowledge of basic science, and electrical engineering fundamental.
PLO 2	In-depth technical competence in an electrical discipline.
PLO 3	The ability to communicate effectively/use ICT effectively.
PLO 4	The ability to use techniques, skills, modern engineering tools necessary for electrical engineering practice and easily adaptable to industrial needs.
PLO 5	The ability to identify problems, creates solutions, innovate and improve current designs and practices.
PLO 6	An understanding of professional and ethical responsibilities and commitment to the community.
PLO 7	A recognition of the need for, and an ability to engage in, life-long learning (adaptability to new situations and demands by applying and or updating knowledge and skills).
PLO 8	The ability to function effectively in groups in ways that contribute to effective working relationships and the achievement of goal both as a leader as well as and effective team player.
PLO 9	The ability to have an international perspective on social, cultural, global and international responsibilities, including the understanding of entrepreneurship and the process of innovation, of a professional engineer and the need for sustainable development.
PLO 10	The ability to appreciate aesthetic values through development and applications of personal judgment.

PLO assessment through courses analysis of all students

All academic staff were ask to complete a PLO survey based on the typical assessment through quizzes, tests, final examination, embedded mini projects, laboratory works, PBL/POPBL and industrial visits. The survey is done for students of Semester 2 Session 07/08 and Semester 1 Session 08/09. The whole process involved each academic staff to complete the Cummulative Marking Scheme for PLO Assessment, a sample which as shown in Figure 1. It consists of assessment methods against the students. Each academic staff can choose any assessment methods he/she likes, but the Faculty needs to ensure that all the PLOs are covered. To make the process of assessment and data collection easier each type is specified either cognitive, affective and psychomotor. In order to properly evaluate the outcomes, PLOs are divided into two categories; Technical Skills and Generic Skills. PLO1, PLO2, PLO4 and PLO5 are considered technical skills whereas PLO3, PLO6, PLO7, PLO8, PLO9 and PLO10 are considered generic skills. For each assessment method, it covers several PLOs. For quiz, tests and final examination, they covers PLO1, PLO2, PLO4 and PLO5. For assignment it covers PLO1, PLO3, PLO4, PLO5, PLO6 and PLO7. A project covers PLO2, PLO3, PLO4, PLO5 and PLO8. Student centered learning such as PBL or POPBL, it covers PLO3, PLO4, PLO5, PLO7, PLO8, PLO9 and PLO10. Occasionally, the course lecturer organises an industrial visit. This activity, in effect can be used to evaluate student's generic skills. Hence industrial visits can be evaluated to cover PLO3, PLO6, PLO7, PLO8, PLO9, and PLO10. Suitable set of rubric is needed though.

For Technical Skills assessment, cognitive assessment through quizzes, tests and final examination is in the taken as a form of quantitative evaluation. For Generic Skills, each academic staff can evaluate by using their own rubrics for each attribute, preferably with scale from 1 to 5, averaging and normalising the final scores to 100%. They can also use the rubric on the OBE website.

The results are tabulated into a form shown in Figure 1, for each student against assessment methods. The data was extracted and tabulated into a new table. The table consisted of data collected for courses that were offered during Session 0708 Semester 2 and Session 0809 Semester 1 respectively. Figure 2 shows the graph of mean score for each PLO plotted against PLO number, for Session 0708 Semester 2 and Session 0809 Semester 1 respectively. It can be concluded that the PLO Assessment through courses analysis of all students has met the Key Performance Indicator (KPI) target of 60% for average value of PLOs.

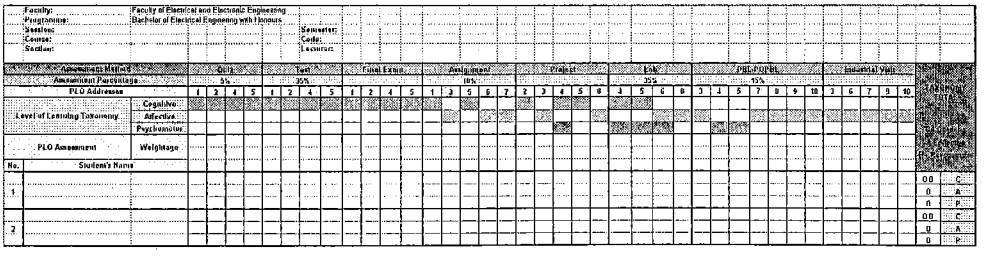

Figure 1 Cummulative Marking Scheme for the PLO Assessment in Each Course

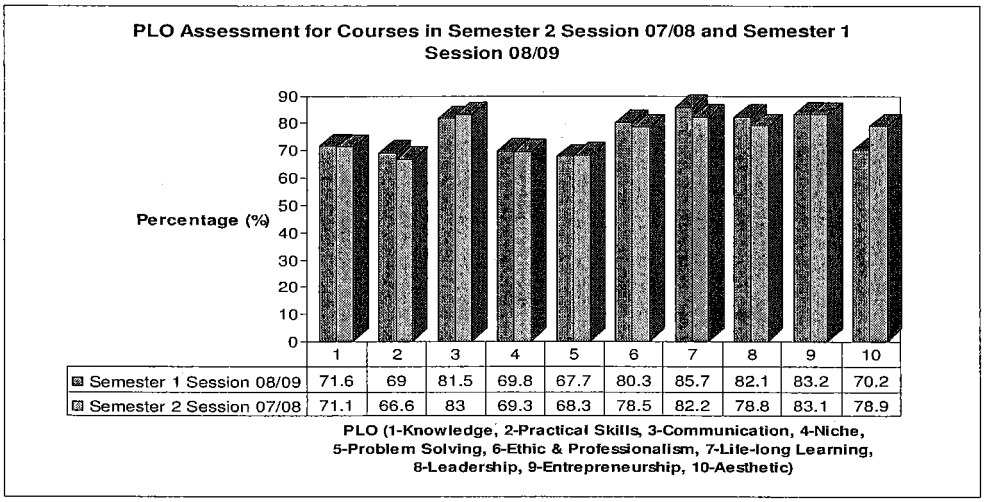

Figure 2 The graph mean PLO assessment score in percentage against PLOs for courses offered in Session 07/08 Semester 2 and Session 08/09 Semester 1

PLO assessment through graduate exit survey

An exit survey is conducted for graduating students just before convocation day. For FKEE, we organise a symposium called FIES2008. Through this symposium students are asked to share their experience, and presented as a form of seminar. Survey questions directly reflect the program outcomes of the faculty. Shown in Figure 3 are the results of the Program Learning Outcomes Surveys conducted in Aug 2008, about a week before the convocation day. The responses are rated from 1 through 5 (5 being Strongly Agree, 1 being Strongly Disagree). This survey reflects on the implementation of the BEE curriculum for the students admitting in cohort July 2004. The next survey which will be done in April 09, reflect the students admitting in cohort January 2005. This survey involved 170 students.

From the graph in Figure 3 it is noted that the score for each PLO is given as in Table 2. Therefore, the average percentage of the PLOs for graduate exit survey is 83% which is well above KPI.

Table 2 Percentage Score

PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
88%	78%	87%	82%	75%	85%	86%	90%	76%	83%

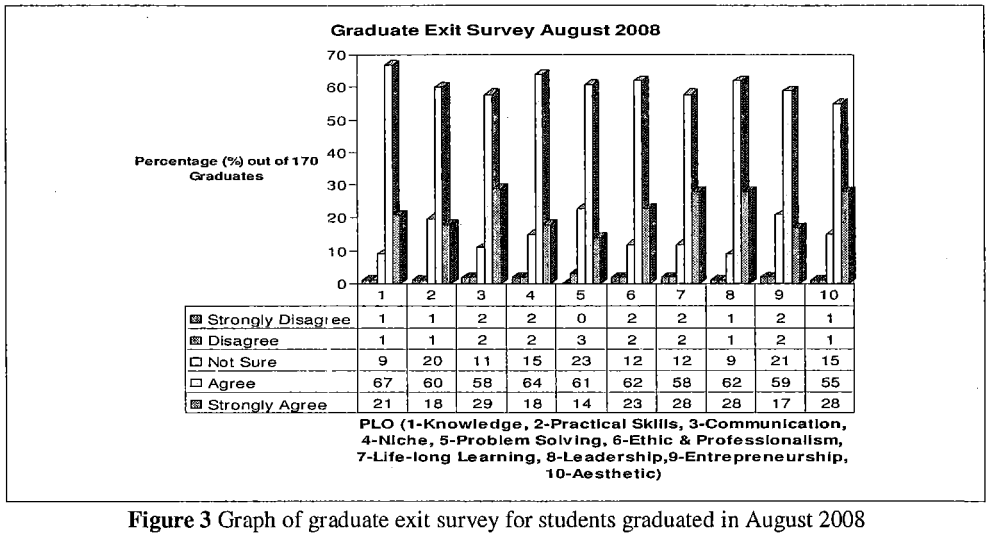

Figure 3 Graph of graduate exit survey for students graduated in August 2008

PLO Assessment through Adequacy Survey to the Employers

A survey was conducted to test the adequacy of our Programme Learning Outcomes to the employers. The number of respondents is **36** employers. The responses are rated from 1 through 5 (5 being Strongly Agree, 1 being Strongly Disagree). This survey reflects on the effectiveness of the implementation of the BEE curriculum for the FKEE students. It also shows that the employers prefered these stated PLOs. The detail results are tabulated and graphed as shown in Figure 4. From the graph in Figure 4 it is noted that the score for "Strongly Agree" and "Agree" for each PLO is given as Table 3.

Table 3 PLO adequacy survey to employers

PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
85%	92%	91%	95%	97%	97%	89%	95%	82%	76%

The average percentage of the PLOs for the adequacy survey from the employers is 90% which is well above the stated KPI. Hence it can be concluded that the PLOs that was designed completely adequate and satisfied the industries.

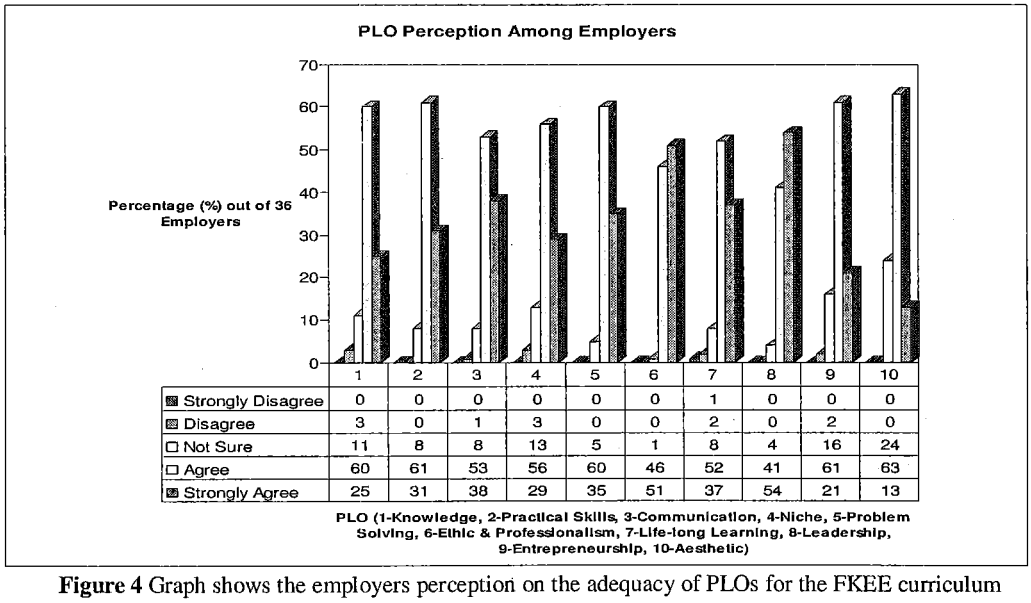

Figure 4 Graph shows the employers perception on the adequacy of PLOs for the FKEE curriculum

PLO assessment through industrial training employers survey

After the student completed their eighth semester of their Electrical Engineering degree programme, it is compulsory for them to undergo industrial training at the designated industries based on their final semester electives. The industrial training period covers up to 12 weeks and the students were attached to several large and medium size companies and corporations. For programme learning outcomes, it seems that all the PLO can be assessed from their experience in the industry. In fact during the training, the students are closely monitored by engineers who are also their training supervisors. Besides supervising the student the supervisors are also requested to certify records of daily activities written in the students' log book and to assess the students' performance during the training.

The current industrial training employers' survey results are for student undergone **12** weeks Industrial Training during Session **07/08**, from May 08 until August 08. The assessment was done by the employers which evaluate the student performances based on three categories: **(a) Technical knowledge; (b) Technical Skill; (c) Generic Skills**. Within these categories they were assessed based on their background knowledge, ability to apply knowledge, punctuality, capability and efficiency in carrying out duties, ability in carrying out supervisor's instruction, independence, innovation and ingenuity in solving problems. Other aspects included their interest in the work, communication skill, behaviour and appearance. Each factor was rated from 1(Strongly Disagree) to 5 (Strongly Agreed). These factors were used to determine whether the student attained their PLO. The results were tabulated. In analysing the survey results, matrix of the PLOs to the questionnaires was built and the results for each PLO were normalised to 100%. **Our KPI for PLO is 60%**. If any PLO falls below that, the Faculty management will need to be informed.

The results produced by 152 respondents are tabulated graphed as in the Figure 5. In analysing the questions and the PLOs, the PLOs are related to the questions (A1-A3, B1 – B2 , C1 – C8) as follows:

A1 : PLO1	**A2 : PLO2**	**A3 : PLO3**	**A4 : PLO4**	**A5 : PLO5**
B1 : PLO1 and PLO2	**B2 : PLO1 and PLO2**			
C1 : PLO3	**C2 : PLO4**	**C3 : PLO5**	**C4 : PLO6**	**C5 : PLO7**
C6 : PLO8	**C7 : PLO9**	**C8 : PLO10**		

After rationalising the results and correlate with the PLOs the following percentage score was obtained for all PLOs as shown in Table 4.

Table 4 Industrial training employers survey

PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
88%	80%	79%	80%	84%	90%	97%	84%	68%	83%

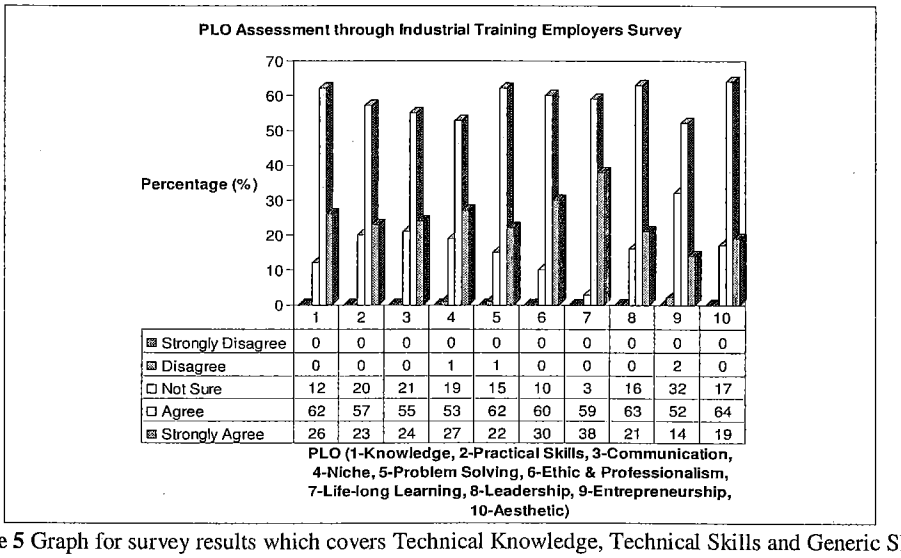

Figure 5 Graph for survey results which covers Technical Knowledge, Technical Skills and Generic Skills

Conclusion

The report has shown the initiatives made by the Faculty to embrace holistically the Outcome Based Engineering Education for the benefit of the Faculty, the University and all the stakeholders. The Faculty has given solid commitment to this cause and has made effort for the process of programme assessment at PLO level being done. The PLO assessments through course analysis, graduate exit survey, learning outcomes adequacy survey to employers, perception of academic staff and assessment through industrial training employers' survey were done. Various points of concern are given. Last and not least the outcome of this assessment has confirmed that the accreditation criteria for PEO and PLO assessment were met. The course structure, design, content, grading system, and improvement process were described. Moreover, one of the used indirect assessment tools (entry and exit surveys of students) was discussed to measure the effectiveness of the course in meeting its goals from the students' perspective. The surveys have provided useful information indicating that the students' attitudes towards engineering seem to be very positive before and after taking the course. Large improvements have been observed in the use of modern engineering techniques and open-ended problem solving skills respectively, as the course was mainly designed for these purpose. To complete the picture of the effectiveness of the assessment, the results of direct measures are being actually compared with the indirect measure results and the pre-semester instructors' expectations. Finally, despite the large improvement already observed, empirical research (using an experimental group and a control group) is needed to help better understanding and documenting the effectiveness of the programme.

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