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Abstract

The entrance-exit survey (EES) is a good tool to measure the student's perceived level of course comprehension while the Continuous Evaluation (CE) was carried out to access the actual student performance. This paper evaluates the PO attainment for the Electric Circuit II course as measured using both EES and CE methods. The samples of 76 students in part three from the Diploma in Electrical Engineering Electronic (EEE111) and Diploma in Electrical Engineering Power (EE112), that enrolled in the course from October 2021 to February 2022 are used in this study. Out of twelve PO provided by the Engineering Technology Accreditation Council (ETAC) for the engineering curriculum program, three PO were linked to this course which are PO1, PO2, and PO4. A total of nineteen survey questions regarding the course content were distributed at the beginning and end of the course and all questions were mapped to the designated PO for analysis. The cognitive and psychomotor aspects are the focus of the knowledge domain associated with the three PO. Aside from that, the PO attainment was also performed using 65% as the specified program achievement requirements. The findings may imply that entry-exit surveys are one method of capturing students' perceived attainment of the targeted learning outcomes, and they may give light to the development of course evaluation measures in general.

Keywords: OBE, Entrance-exit Survey, Program Outcome (PO), Course Outcome (CO)

Introduction

Outcome-Based Education (OBE) is recognized through PO (Program Outcome), CO (Course Outcome), and PEO (Program Educational Objectives). The OBE was carried out using the recommended methodology to obtain the PO, which was linked to COs and the course evaluation metrics. The CO for each course counsel to enhance the performance of students' learning and lecturers' teaching skills. At the end of each course, there is a comprehensive scope of statements in the CO that describe what the student should be learning, and every student's progress was tracked throughout their courses based on COs and POs relationship.

In addition to providing information to POs, CO evaluation in OBE practices will also help to identify the underachievers (Chandna, 2016).

Program outcomes (POs) are statements of what criteria students should be attained in terms of knowledge, skills, values, and behavior by the time they graduate. Essentially, the diploma program in Electrical Engineering implements the POs under the guidance of the Engineering Technician Accreditation Standard 2020 (BEM, 2020) which consider a critical component in obtaining Program accreditation by the Professional Body – Board of Engineering Malaysia (BEM). The PO attainment level is usually determined by the Institute of Higher Learning (IHL). The minimum level of PO attainment for the Diploma Program of Electrical Engineering is 65% which indicates at least 65% of total students should pass the assessment. The PO attainment is measured using assessment modules with defined rubrics, and the CO is linked to a specific measured PO.

Learning Domain and Related POs

Benjamin Bloom, an American educational psychologist, grouped learning objectives into three groups in his taxonomy of learning: cognitive, psychomotor, and effective. Bloom's taxonomy appears to have a major theoretical effect on learning outcomes and progress theory. The first version of the taxonomy, published in 1956, establishes a hierarchical classification of cognitive learning, progressing from fundamental (knowledge and understanding) to progressively complicated abilities (application, analysis, synthesis, and evaluation of concepts, processes, procedures, and principles) (Adesoji, 2018). The cognitive domain was altered in 2001 by altering the nouns used in the original version to verb form (knowing was changed to remembering; comprehension was changed to understanding) and placing synthesis (creating) above assessment (evaluating) in the greatest degree of complexity (Krathwohl, 2001). A second version outlined a learning hierarchy for the emotional domain, beginning with the fundamentals (receiving and reacting) and progressing to more complicated levels (valuing, organization, characterization by a value or value complex) (Mutlu et al., 2022). A further advancement presented a hierarchy characterizing the psychomotor domain (skills), beginning with imitation, and progressing to articulation and naturalization via manipulation accuracy. The mapping between three learning domains with PO provided by the ETAC in engineering program curriculum design is elaborated follows:

1) Cognitive Domain

Cognitive refers to an individual's intellectual activity in obtaining knowledge. Students' cognitive learning experiences are mostly exposed in the program's lower semester, particularly in engineering foundational courses. While the examination of cognitive aspects is based on the Bloom Taxonomy of six (6) cognitive levels, they are as follows: remembering (C1), comprehending (C2), applying (C3), analysing (C4), evaluating (C5), and creating (C6) (Adams, 2015). The syllabus for the diploma degree in Electrical Engineering focused components C1 through C4. In the upper semester of the curriculum, the evaluation on components C5 through C6 engaged just 5-10% of the students. There are three (3) POs connected to the Cognitive element: PO1 on knowledge, PO2 on problem analysis, and PO3 on solution design/development.

2) Psychomotor Domain

The Psychomotor Domain connects talents and practical factors using hardware or software instruments. The psychomotor part of engineering curriculum design should account for at least 50% of the curriculum. PO4 on Investigation and PO5 on ability to utilize current tools are two of the twelve POs tied to the psychomotor component.

3) *Affective Domain*

In the Affective domain, values and behavior are instilled in students' learning experiences throughout the programme to create complete student development, which includes the remaining seven (7) POs, which include PO6 on Engineering & Society, PO7 on Environment & Sustainability, PO8 on Ethics, PO9 on Individual and Teamwork, PO10 on Communications, PO11 on Project Management & Finance, and PO12 on Life-long Learning.

The Entrance and Exit Surveys

Significant information on the strengths and weaknesses of that particular curriculum programme or course in terms of knowledge, facilities, professionalism, and happiness index can be collected by using the student feedback method that examines after graduation or completion of the course (Othman et al., 2011). The Canadian Engineering Accreditation Board (CEAB) has established a system similar to the entrance and exit surveys concept, that allow students to self-assess their graduating qualifications as a proactive approach to improving their engineering program (Milne et al., 2014). Entrance and exit surveys are conducted using the same set of questions at the beginning and end of a particular course or curriculum program. OBE implementation can be assisted by excellent platforms and tools offered by Universiti Teknologi MARA (UiTM). The online database web portal utilized by all UiTM users in conducting online learning is UFUTURE platform. Furthermore, UFUTURE can administer the Entrance-Exit Survey (EES) and Student Feedback Online (SUFO) at the end of each course (Abedin et al., 2014).

The purpose of this paper is to conduct a study of EES, and student performance based on designated PO for Electric Circuit II course. The surveys are compulsory to all registered students and filled by using the official University's online learning portal, UFUTURE. For the analysis, the course of Electric Circuit II was selected, which is completed by diploma students of Electrical Engineering, Universiti Teknologi MARA. A total of seven chapters are covered in this course, which emphasizes the analysis of direct current (DC) and alternating current (AC). Among the topics covered in the course are DC transient analysis, sinusoidal steady-state analysis, circuit laws, methods, and theorems, AC power analysis, magnetically coupled circuits, two-port networks, and resonant circuits.

Research Methodology

1) *The course*

The course has been adequately prepared to meet ETAC's requirements for an Electrical Engineering diploma. Students should be able to apply the fundamental principles, methods, and theorems of resistive, inductive, and capacitive (RLC) problems to the analysis of direct current (DC) and alternating current (AC) throughout the course. As well as circuit analysis such as mesh and nodal, students should be able to understand superposition, source transformation, and Norton's theorem and magnetically coupled circuits. Simulations and electronic components can also be used by students to conduct DC and AC analyses. In this course, three of ETAC's twelve POs were applied, specifically PO1, PO2, and PO4. Generally, the PO1 focuses on knowledge, the PO2 on problem analysis, and the PO4 focuses on investigative skills. There are three evaluation domains, according to Bloom's Taxonomy: cognitive, psychomotor, and affective. The cognitive domain was used to access the PO1 and

PO2, whereas the psychomotor domain was used to reach the PO4 through lab work and practical test activities.

2) The samples

A sample of 76 students from the School of Electrical Engineering, Universiti Teknolologi Mara (UiTM) Johor, Pasir Gudang branch, has been chosen for the semester October 2021 to February 2022 in answered the surveys questions. There were 49 Diploma of Electrical Engineering (Electronics) - EE111 students and 29 Diploma of Electrical Engineering (Power) - EE112 students. Figure 1 illustrates the number of students in both program (EE111 and EE112). There are five groups of students: three from EE111 and two from EE112, and three lecturers have been assigned to teach this course this semester.

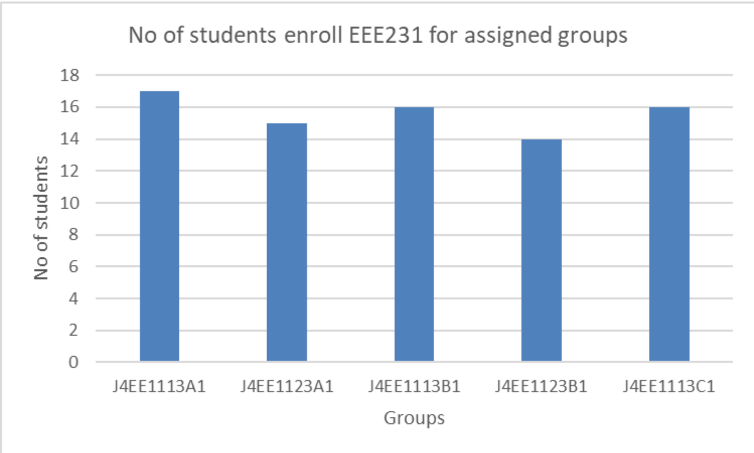


Figure 1: Number of students enrolled in Electric Circuit course by groups

3) Entrance and Exit survey (EES)

During the first week of the semester, lecturers for the Electric Circuit II course were asked to conduct an entrance survey to measure students' comprehension before the lecture. During the first lecture, lecturers must describe the Outcome Based Education (OBE) requirements for this topic in terms of PO and CO statement. The syllabus for this course was presented throughout the semester session in accordance with the recommendations from the OBE requirement. At the end of the semester, exit survey was conducted using the same set of questions to access the student’s performance based on OBE implementation. The frequency differences between entry and exit score of each question was computed and recorded. In this course, total 19 questions were asked in the EES process as represented in Table 1.

Table 1
The EES Questions for Electric Circuit II course

EES Question no	EES List of Questions
1	I can differentiate the Natural and Step Response for RL and RC circuits.
2	I can calculate the initial value, final value, time constant, current and voltage for RL and RC circuits.
3	I can determine the general equation for Natural and Step Response.
4	I can sketch the Response.
5	I can explain the basic of Sinusoids and phasors, impedance and admittance.
6	I can calculate the current, voltage and power for specific circuit elements in time domain and frequency domain.
7	I can differentiate between Instantaneous and Average Power, Apparent Power and Complex Power.
8	I can identify and calculate Instantaneous and Average Power, Maximum Average Power Transfer, Effective or RMS Value, Apparent Power and Complex Power.
9	I can analyze the power factor and power factor corrections.
10	I can define the term of Self Inductance, Mutual Inductance, Coupling Co-efficient and Dot Determination in magnetic circuit.
11	I can apply the technique of mesh analysis to solve problem in the magnetic circuit.
12	I can define the Series Resonance Circuit and Parallel Resonance Circuit.
13	I can determine the Quality Factor and Bandwidth.
14	I can analyze the resonant circuit to determine the inductor and capacitor.
15	I can apply Kirchoff's law, Voltage Divider Rule (VDR) and Current Divider Rule (CDR).
16	I can determine equivalent impedance using series parallel concept and wye-delta transformation.
17	I can apply the technique and solve electrical circuit parameter using source transformation technique, nodal analysis technique, mesh analysis technique, Thevenin/Norton theorem, and superposition theorem.
18	I can determine the Z-parameter, Y-parameter and T (ABCD)-Parameter construction.
19	I can analyze the Terminated Two Port Network.

There are five scale for students to do a self-rating in this EES: 0-poor, 1-fair, 2-good, 3-very good, and 4-excellent. These EES questions are linked to each topic in the curriculum. Table 2 shows the EES question related to the respective POs, Course chapters and taxonomy domain. Each chapter must include at least two EES questions, and the chapter with the most EES questions is Chapter 1, DC Transient Analysis. The first six EES questions and the last five are linked to PO1, whereas EES questions 1–9, 12–14, and 18–19 are mapped to PO4 skills. The EES questions for PO2 are just between questions 7 and 14 as detailed in table 2.

Table 2
The mapping of Electric Circuit course POs with EES question

EES question no	Electric Circuit II Chapter covered	PO1	PO2	PO4
		Cognitive	Cognitive	Psychomotor
1	1	√		√
2	1	√		√
3	1	√		√
4	1	√		√
5	2	√		√
6	2	√		√
7	4		√	√
8	4		√	√
9	4		√	√
10	5		√	
11	5		√	
12	7		√	√
13	7		√	√
14	7		√	√
15	3	√		
16	3	√		
17	3	√		
18	6	√		√
19	6	√		√

4) The assessment

Figure 2 describes the classification of assessment types for all topics covered in the Electric Circuit course. The evaluation domain and method of assessment used to quantify CO have been determined by the course's Resource Person (RP) and must be followed by all lecturers. The RP will standardize all of the assessment weightage and assign it to the Lecturer in Charge (LIC) for each campus for implementation. For this course, CO1 and CO2 will be tested in Test 1 and Test 2. In Test 1, CO1 and CO2 were assessed 30 and 10 marks from total of 40 respectively. Meanwhile, the remaining CO2 was assessed in Test 2 which consumed total of 40 marks. The weightage for both CO1 and CO2 was set to 30 % and 40 % respectively. The syndicated marking technique was used for both tests to standardize the marking style and reduce the possibility of biases in the scoring process. To access CO3, the practical test, and laboratory exercises were conducted that contributed to 30% of the continuous assessment marks. Six experiments were carried out by the students during the laboratory session. Lecturers will assess their practical abilities in carrying out and debugging the experiments. This evaluation must adhere to the established standard rubrics. The total score for CO1, CO2, and CO3 is 100 %.

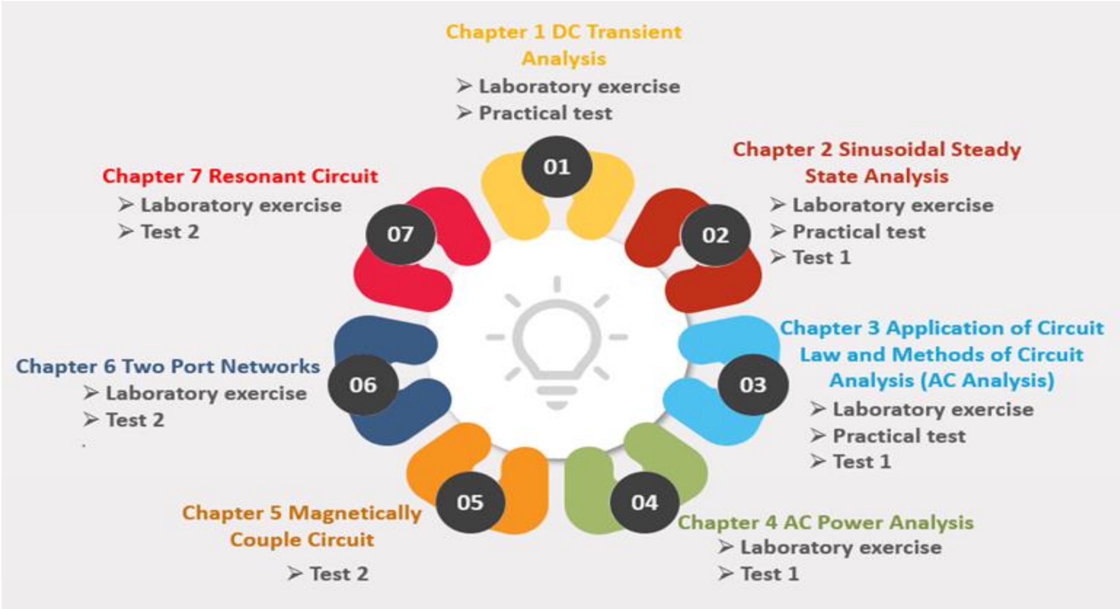


Figure 2: The type of assessments according to each chapter

Result and Discussion

There are 2 Programs i.e., EE111 (Electrical Engineering (Electronics)) and EE112 (Electrical Engineering (Power)) were evaluated. The results are based on Entrance-Exit Survey (EES) output that was used to assess the efficacy of teaching and learning via student self-rating process. Secondly, the course end evaluation output cognitive and psychomotor assessments through exam and lab work activities for both Programs respectively. The EES and course continual assessment analyses are mapped with the CO:PO matrix.

1) *Entrance-exit survey (EES) analysis*

Prior to the course, all students EE111 and EE112 were performed self-rated EES questionnaire as listed in Table 1 (Methodology section). There are five possible ratings: 0 for poor, 1 for fair, 2 for good, 3 for very good, and 4 for excellent. Students usually rank their knowledge and abilities on a scale of 0 to 3 in the entrance survey. If the teaching and learning process was effective, the student's exit score should be between 4 and 5. As a result, the frequency score in this analysis is obtained by subtracting the exit score to the entry score.

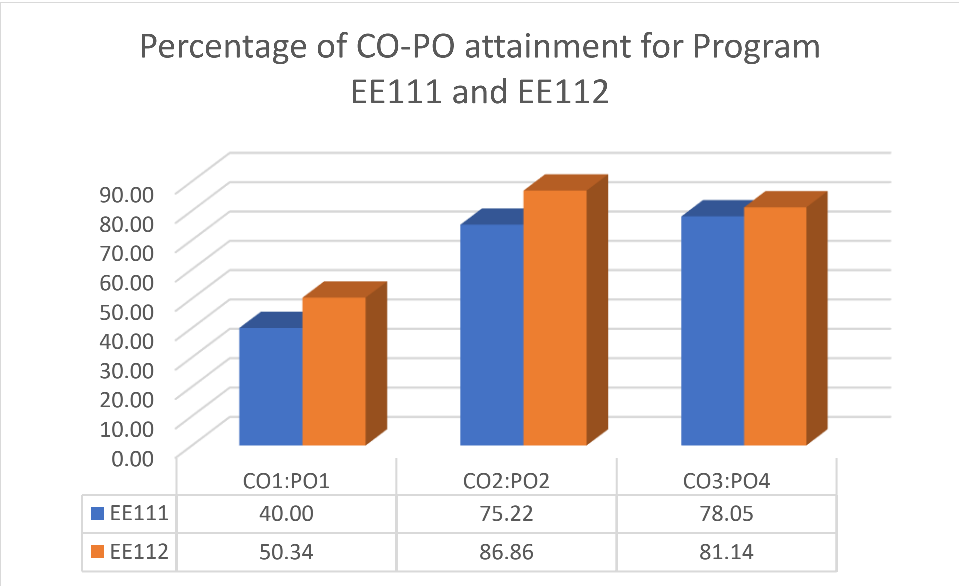
$$Frequency\ score = exit\ score - entrance\ score \quad (1)$$

Figure 3 depicts the frequency score of EES for questions that dedicated to access PO1. The PO1 evaluate knowledge gained during the course learning process. The domination of scoring is in between 3 and 4 that represent the teaching and learning effectiveness is exceptional from the students' perceptions. Figure 4 shows the frequency score between EES for questions that access performance on teaching and learning of PO2, which assessed the problem analysis skills in the course learning process. Total eight questions are related to the PO2. Based on the results, frequency score was also dominated between 3 and 4, indicating that teaching and learning effectiveness is in upright condition. Figure 5 represents the EES frequency score for PO4 (investigation skills). Like the result for PO1 and student's self-rating was dominated in the score of 3 and 4, representing good effectiveness output. In addition, less than 20% of pupils assessed their knowledge and understanding with a frequency score of 2. This indicates that some of the topics accessed for this PO are extremely complex from the student's point of view.

PO1 (EE111)

Figure 3: The frequency score between EES in accessing PO1 for EE111 and EE112 Program
Figure 4: The frequency score between EES in accessing PO2
Figure 5: The frequency score between EES in accessing PO4

2) The assessment



PO1 (EE112)

Figure 5: CO-PO Attainment for EE111 and EE112 Program

Figure 5 shows the percentage of students' achievement for overall course assessment based on CO1:PO1 CO2:PO2 and CO3:PO4. The minimum percentage of each PO attainment to be achieved is set at 65%. For PO1, the achievement slightly below 65 % due to this is the first assessment (a part of test 1) conducted for this course. Furthermore, the teaching, learning, and evaluation for these samples were completed online. Although the students' perceptions of their fundamental knowledge were good, their actual performance access for this PO1 did not meet expectations. The performance for PO2, however, has exceeded the performance criteria of 65%. This being the second evaluation (test 2), the student can get the necessary problem-analysis skills for the course. Finally, for PO4, students achieved the required PO achievement at 78.05 percent for EE111 and 81.14 percent for EE112, respectively. Through lab work and a practical test, the PO4 was assessed to see whether the students' investigative skills had improved. The current semester's PO achievement may be utilized as a reference for the following semester's Continuous Quality Improvement (CQI) references to improve the teaching and learning technique because the sample students are the first batch for ETAC's programme. For instance, the person in charge of the course the next semester may develop a strategy to use several programs, such as the mentor-mentee and flip-classroom concepts, to enhance the unachieved PO. If such actions have no effect, the report can also be used as a reference when the curriculum is reviewed every five years.

Conclusion

This paper evaluates and study the student's performance based on EES and PO attainment. The EES question with 5 Likert scales was designed based on the syllabus content of the course, and each related question has been mapped to the respective PO. There are three related POs mapped to the course, which are PO1, PO2, and PO4. All the data points are analysed based on the frequency score of EES with related POs and COPO attainment in percentage. From the finding the dominated frequency score between EES is at scale 3 and 4. From this, students self-rated themselves able to apply mathematical and scientific knowledge, analyse problems and conduct investigations very well upon completion the course. However, the student's performance measured by continuous assessment shows not comply for PO1 (apply fundamental knowledge). This research study only focuses on the students' performance based on the course and manually analyses using MS Excel for course improvement and evaluation. Therefore, future research should be devoted to the development of a database on the PO attainment for all the courses, and the analysis of the PO attainment can be generated automatically for evaluation purposes and course improvement.

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