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# Optimisation strategy to measure programme outcomes of the Electrical Engineering Degree Programme

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ABSTRACT: An initiative has been taken by the Department of Electrical, Electronic and Systems Engineering (EESE), Universiti Kebangsaan Malaysia, to inculcate the culture of measuring programme outcomes (PO) among the lecturers by optimising the PO mapping for each engineering degree programme. This improvement is the result of extensive research on previous PO mappings, which the lecturers found to be very tedious to measure and less effective. Formerly, the lecturers were given full trust to decide which PO they wanted to measure for each subject. This practice has led to over emphasis, inconsistency and redundancy in the PO evaluation. Thus, it is difficult to monitor the achievement for each programme. To overcome the issue, reduction of the PO measurement has been carried out for all the programmes offered in the department. This reduction is derived from the existing PO's mapping and distribution, after factoring the feedbacks from the programme coordinators and the lecturers. As a result, the new PO mappings, which are more optimised have been devised. The new mappings are expected to ease the process of collecting and analysing the PO achievements from the respective lecturers that are involved in the direct assessment of the PO. This will result in more efficient and accurate PO representation for all degree programmes.

Keywords: Accreditation, continuous quality improvement (CQI), course outcome mapping, optimisation, programme outcome

## INTRODUCTION

Course outcomes (COs) have been developed from a collaborative effort to *design* the teaching and learning experience to meet programme outcomes (POs). POs are direct representations of the collective COs achievement from a specific course. Based on the recent Malaysia's Engineering Accreditation Council (EAC) manual of 2012, the evaluation of student COs achievement need to be done at both the programme level and course level [1]. For each course offered by an engineering degree programme, there is a need to establish a matrix to map the relationship between the COs and POs. The COs-POs matrix is expected to be comprehensive and allows direct measurement of the programme or course achievement. However, the Department of Electrical, Electronic and Systems Engineering (EESE), Universiti Kebangsaan Malaysia, has encountered inconsistency and inefficiency in terms of POs measurement since the introduction of the COs-POs mapping-based system.

The mapping of COs-POs exhibits relevant learning activities, strategies and measurement tools involved in each course. In addition, a clear and optimised COs-POs mapping at the programme level will provide an overview, gaps or overlaps that exist in the development, practice, discipline requirements and programme evaluation [2].

This will indirectly help to improve the implementation of POs assessment; thus, systematic quality management can be taken to monitor effectively and evaluate the graduate's attributes (from the measured POs) [3].

In addition, drawbacks and deficiency of the COs-POs mapping can be detected more accurately, thus helping the programme coordinator and the lecturers to perform continuous quality improvement (CQI) on the electrical engineering degree programme structure, delivery methods and assessments [4].

This article presents the collaborative effort, taken by the lecturers in the Department to simplify the POs assessment method in three engineering degree programmes, which are: 1) Electrical and Electronic, EE; 2) Microelectronics; and 3) Communications and Computers, CC. The main objectives of this article are: 1) to optimise the existing COs-POs mapping, thus, helping to simplify the monitoring and evaluation process at programme and course level; and 2) to increase the awareness on POs assessment among the academic staffs within EESE. The results from this study contribute towards the continuous quality improvement (CQI) efforts to enhance the quality of teaching and learning implementation in the EESE.

DESCRIPTION OF UNDERTAKEN APPROACHES

A comprehensive and high level view on the COs-POs mapping is important to ensure that the engineering degree programme meets all of the important student attributes [5]. In the EESE, the student attributes, which are administered and regulated by the EAC can be measured from nine POs, which are:

- PO1- apply knowledge;
- PO2 - identification, formulation and solving problems;
- PO3 – engineering design;
- PO4 - responsibility;
- PO5 - conducting experiments;
- PO6 - project management;
- PO7 - communication skills;
- PO8 - teamwork;
- PO9 - lifelong learning.

Previous practice suggests that the lecturer for a specific course decides the COs-POs mapping individually, before it will be implemented at the degree programme level. During that time, there is no coordinator or committee to overseas the CO-POs mapping at the programme level, as the outcome based education (OBE) implementation within the EESE can be considered to be at a premature level. However, since the implementation of COs-POs mapping for the past few years, feedback given by the lecturers imply that the POs evaluation process at the course level is a very tedious task and ineffective.

At the programme level, most of the courses share similar COs-POs mapping, i.e. redundant evaluation is done on the same PO attribute. In addition, some of the COs-POs mapping matrices are obsolete and not relevant to the current engineering practice due to technological advancements (for example, latest microprocessor assembly language is highly desired in the job market than the older version) and does not meet the stakeholders' criteria of an engineering graduate, especially, from the employers view. These situations resulted in redundant and imbalanced COs-POs mapping at the programme level; thus, complicating the POs evaluation process among the lecturers.

Table 1 shows an example of existing COs-POs mapping of a course offered in the EE programme. This mapping shows a direct relationship between COs that need to be achieved after the students have completed the course. These COs are, then, mapped on the POs, which are the nine main attributes that need to be achieved by the students prior to graduation. Table 1 shows that the total of six COs need to be evaluated to determine the student performance and its direct relationship with the POs achievement. However, it can be seen that the total number of COs that need to be evaluated was 24, considering both the CO and PO components.

As an example, for CO2, lecturers need to evaluate four aspects that are represented by different POs (PO1, PO2, PO3 and PO8). It is obvious that CO2 has been evaluated across all four POs, which represent different attributes, resulting in an inaccurate representation of POs achievement for each course. On the same note, PO1 is heavily evaluated across all six COs; thus, cause the evaluation process to be complicated and make it difficult for the lecturer to perform the evaluation. The problem becomes worse when the COs-POS mapping for all the courses plotted at the programme level, which eventually leads to an inaccurate POs achievement and unnecessary COs-POs representation at the programme level.

Table 1: Example of COs-POs mapping from one of the courses offered in the EESE (course title: Control System Design, course code: KKKZ4124), a) before optimisation and b) after optimisation.

| No | Course outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | Mode of delivery | Assessment methods |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Ability to describe the structure and techniques to design a control system in a group. *Cognitive level 1 (Knowledge).* | √ | | | | | | | | | Lecture and tutorial | Quiz/assignment, examination |
| 2 | Ability to interpret design specifications and also control system in time domain and frequency domain. *Cognitive level 3 (Application)* | √ | √ | √ | | | | | √ | | Lecture, tutorial, PBL and cooperative learning | Quiz/assignment, report and examination |
| 3 | Ability to determine the control system strategy based on the control objectives in time domain and frequency domain. *Cognitive level 4 (Analysis)* | √ | √ | √ | | | | | √ | | Lecture, tutorial, PBL and cooperative learning | Quiz/assignment, report and examination |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4 | Ability to design a control system suitably used in time domain and frequency domain. *Cognitive level 4 (Analysis)* | √ | √ | √ | | | √ | | √ | | Lecture, tutorial, PBL and cooperative learning | Quiz/assignment, report and examination |
| 5 | Ability to evaluate and give comments on the developed control system. *Cognitive level 6 (Evaluation)* | √ | √ | √ | | | √ | | √ | | Lecture, tutorial, PBL and cooperative learning | Quiz/assignment, report and examination |
| 6 | Ability to design a robust control system. *Cognitive level 5 (Synthesis)* | √ | √ | √ | | | √ | | √ | | Lecture and tutorial | Quiz/assignment, examination |
| Overall PO assessment for this course | | √ | √ | √ | | | √ | | √ | | **√ = PO will be evaluated based on the course outcome | |

a) Before optimisation.

| No | Course outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | Mode of delivery | Assessment methods |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Ability to describe the structure and techniques to design a control system in a group. *Cognitive level 1 (Knowledge).* | | | | | | | √ | | | Lecture and tutorial | Quiz/assignment, examination |
| 2 | Ability to interpret design specifications and also control system in time domain and frequency domain. *Cognitive level 3 (Application)* | | | √ | | | | | | | Lecture, tutorial, PBL and cooperative learning | Quiz/assignment, report and examination |
| 3 | Ability to determine the control system strategy based on the control objectives in time domain and frequency domain. *Cognitive level 4 (Analysis)* | | √ | | | | | | | | Lecture, tutorial, PBL and cooperative learning | Quiz/assignment, report and examination |
| 4 | Ability to design a control system suitably used in time domain and frequency domain. *Cognitive level 4 (Analysis)* | | | √ | | | | | | | Lecture, tutorial, PBL and cooperative learning | Quiz/assignment, report and examination |
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| 6 | Ability to design a robust control system. *Cognitive level 5 (Synthesis)* | | √ | | | | | | | | Lecture and tutorial | Quiz/assignment, examination |
| Overall PO assessment for this course | | | √ | √ | | | | √ | | | **√ = PO will be evaluated based on the course outcome | |

b) After optimisation.

RESULTS AND DISCUSSION

Based on previous practice in the EESE, the lecturers for each respective course were given full responsibility to determine which POs need to be assessed in their course. However, this method has resulted in inconsistency of the course outcomes and programme outcomes mapping, where some of the courses have too many POs to be evaluated and create overlapping assessment issues. Realising the shortcomings of the previous approach, all the lecturers in the EESE have taken the initiative to map the previous CO-PO assessment at the degree programme level. This is done from a half-day focus group discussion among the lecturers, organised by all three degree programme coordinators.

The outcome from the mapping task is shown in Figure 1. It can be seen that all three degree programmes place a heavy emphasis on evaluation of PO1 (apply knowledge) and PO2 (identification, formulation and solving problems), while there is lack of emphasis on PO3 (engineering design), especially, for the electrical and electronic degree programme. PO3 (engineering design) is often associated with higher cognitive level (evaluation or synthesis); thus, by lack of evaluation on PO3 suggest that the future electrical and electronic graduates from the EESE will have poor skills and exposure to engineering design. As for PO1 and PO2, they are considered as lower cognitive levels (knowledge and comprehension); thus, redundant evaluation on both POs are not necessary, since the graduate is expected to move towards a higher cognitive level as they progress towards the final year.

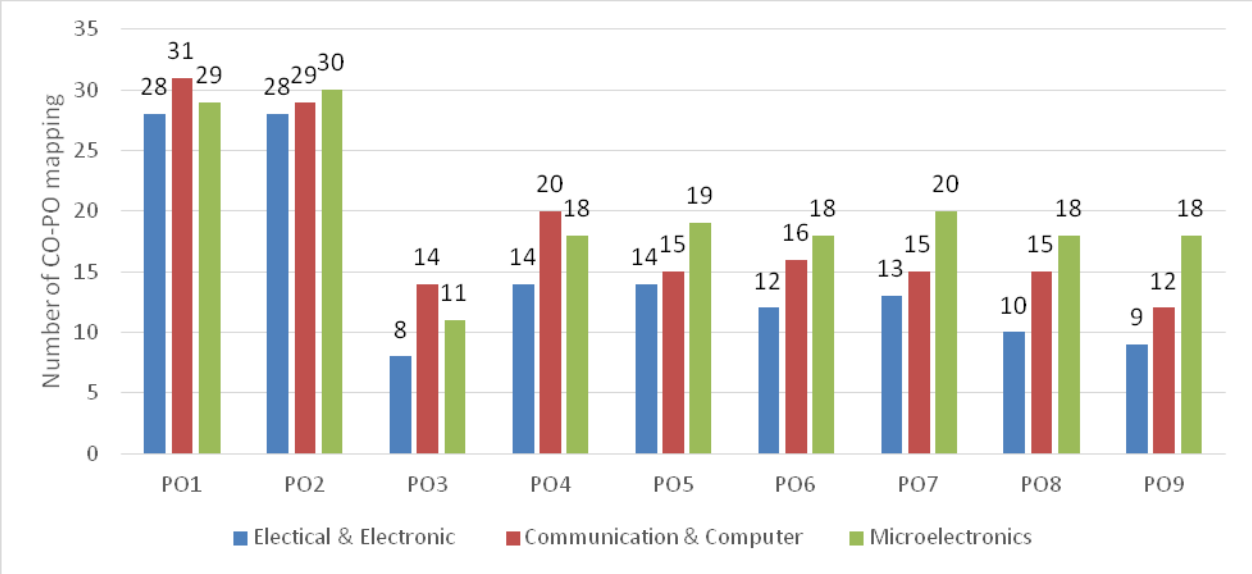


Figure 1: Distribution of the previous CO-PO mapping for three engineering degree programmes offered in the EESE.

In the next phase, the lecturers have to decide among themselves to eliminate the redundancy at the course level and redistribute the CO-PO mapping evenly across all nine POs. This task is also known as an optimisation process. This action was carried out to ensure that the POs were properly mapped to a certain course and, thus, simplify the assessment tasks for the lecturer.

Figure 2 shows the distribution of the assessed POs in three different degree programmes with respect to the nine POs before and after the optimisation process. It can be seen that there is a drastic reduction in the number of the CO-PO mapping for PO1 (average of 40% reduction) and PO2 (average of 44% reduction) for all three degree programmes. The average number of the CO-PO mapping is also reduced for all three programmes, whereby for 1) electrical and electronic from average 15.11 to 12.44; 2) communication and computer from average 18.6 to 11.56; and 3) microelectronics from average 20.1 to 10.8.

The optimisation process has improved the quality of monitoring, assessing and evaluating of the POs, systematically. In addition, it will assist the improvement of the teaching and learning activity where lecturers have to emphasise on the course outcomes evaluation with respect to the allocated programme outcomes.

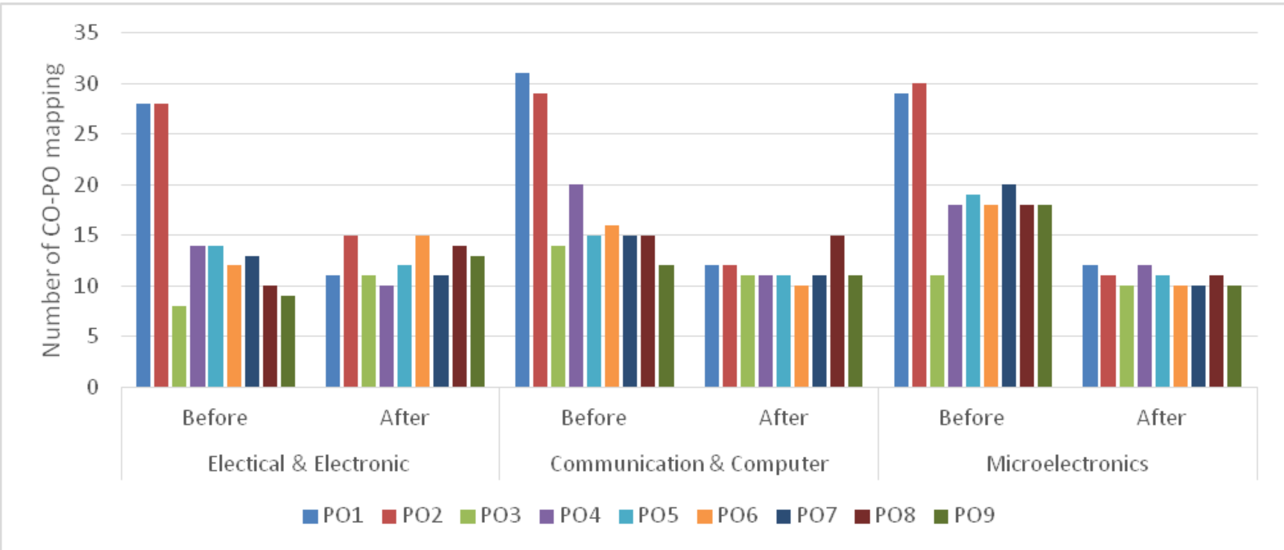


Figure 2: Comparison between before and after optimisation of the CO-PO mapping for all three programmes in EESE.

## CONCLUSIONS AND RECOMMENDATIONS

In conclusion, the EESE has taken the initiative to optimise the mapping of CO-PO for all three engineering degree programmes based on the previous approach, which was found to be inefficient and redundant, and to increase the workload for the lecturers. The optimised CO-PO mappings are derived based on a collaborative effort taken by the lecturers and the programme coordinators to simplify the PO evaluation method. As a result, redundancies in the CO-PO measurement have been reduced for an evenly distributed POs measurement. The optimisation effort is expected to reduce the workload of the lecturers in measuring the CO-PO. This indirectly simplifies the task of monitoring and evaluating the continuous quality improvement process at the programme level.

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BIOGRAPHIES

Rosdiadee Nordin received his Bachelor of Engineering (BEng) degree from Universiti Kebangsaan Malaysia in 2001 and his PhD from the University of Bristol in the United Kingdom in 2011. He is currently a senior lecturer in the Department of Electrical, Electronic and Systems Engineering at Universiti Kebangsaan Malaysia. His main research interests focus on the wireless physical layer, such as advanced multiple antenna, resource allocation, green radio, intercell interference and indoor wireless localisation and potential technology for fifth generation (5G) wireless network. He has also developed an interest towards action research related to engineering education.

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