Global Journal of Engineering Education

Relationship between direct and indirect assessment to improve the teaching and learning process for electrical engineering programmes

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ABSTRACT: The aim of the study presented in this article is to improve the quality of the teaching and learning (T&L) process based on a comparison between direct and indirect methods. The direct method is based on an evaluation of programme outcomes (POs), which is measured according to several assessment tools during the implementation of teaching and learning processes, such as problem based learning (PBL), projects, and mid-semester and final examinations that are embedded into electrical engineering programme courses. Indirect methods involve assessment of students' perception of the knowledge and experience that they have gained throughout the course. Based on the results, there is a strong correlation between both direct and indirect methods. The results also suggest that students have exceeded the expectation of the course outcomes (COs). The methods and results from this study will help the Department of Electrical, Electronic and Systems Engineering (JKEES) in the Faculty of Engineering and Built Environment (FKAB) at Universiti Kebangsaan Malaysia (UKM), Bangi, Malaysia, to monitor the quality of engineering graduates and encourage continuous quality improvement (CQI) processes to enhance the quality of T&L for electrical engineering programmes.

Keywords: Programme outcomes, course outcomes, direct measurement, indirect measurement

INTRODUCTION

An initiative has been taken by the Teaching and Learning Improvement Unit (TLIU) at the University to inculcate the culture of assimilating both direct and indirect measurements of programme outcomes (PO) among the Department of Electrical, Electronic and Systems Engineering (JKEES) lecturers in the Faculty of Engineering and Built Environment (FKAB) of Universiti Kebangsaan Malaysia (UKM).

An outcome-based education (OBE) system has been introduced and comprehensively implemented in JKEES since 2003. The OBE system empahsises the development of self-potential graduates who not only have a solid knowledge foundation, but are also equipped with the latest technology, something that is even more responsible for social change in the environment and the sourrounding community [1]. In the context of OBE implementation in JKEES, the achievement of the system are measured, verified and improved based on Malaysian quality frameworks (MQFs) [2].

Course outcomes (COs) have been developed from a collaborative effort to *design* the T&L experience to meet the POs. POs are direct representations of the collative COs achievement from a specific course. Based on the recent EAC manual, the evaluation of students' COs achievement needs to be done at both the programme and course level [3]. The Department has implemented both indirect and direct assessment of POs to improve assessment of T&L practice in the Department. The indirect assessment is implemented through student self-assessment (SSA), where the students' perception of their achievement of specified COs in a course are collected at the end of every semester.

In addition, the direct assessment in JKEES is achieved by establishing a matrix to map the relationship between the COs and POs. The COs-POs matrix is devised to be comprehensive and allows direct measurements of the programme's achievements [4]. Its implementation involves all lecturers firstly to plan their T&L delivery and methods to measure the identified POs throughout the semester. Periodic evaluation of the COs for a course is conducted by the TLIU in the Department to ensure that the overall goals of the programme and curriculum that have been set are achieved. The process is a part of the continuous quality improvement (CQI) process and the loop is completed at the end of the semester. During this process, if any of the COs set for a course taken is not achieved, problems or weaknesses in the T&L implementation will be identified by the programme coordinator. The programme coordinator is the person responsible for monitoring the POs performance and ensuring that the programme will achieve all POs.

The comparison of direct POs assessment via COs and indirect assessment based on students' perception of Electric and Electronic (EE) Programme offered in JKEES, FKAB, are presented below. The main objective of this study is to establish the correlation between this two assessment methods. Hopefully this effort will instil the spirit of the best direct and indirect assesment practice to improve T&L process in the Department.

METHOD

The evaluation process of POs is carried out using direct and indirect methods of measurement. The direct method of measurement is conducted through the overall POs assessment via COs achievement in selected courses. The indirect method of measurement is performed through SSA. A summary of the assessment methods is presented in Figure 1 below.

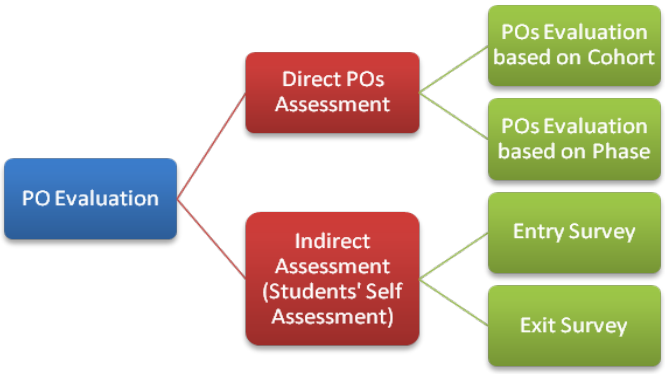

Figure 1: Summary of the assessment methods involved in the POs analysis.

The direct PO assessment is a form of monitoring and diagnostic phase, which covers different phases (or years) of a student's learning experience. Direct POs assessment is done at the end of every semester so that there can be modifications and corrective action to the T&L activities to improve student attainment. Formative assessment is further categorised into two assessment methods: based on a) the phase; and b) the cohort.

The students are divided into three different phases (from Phase 1 to Phase 3) for the following reasons:

- Ease of POs implementation at EE programme level.
- Monitoring processes, especially at the end of every semester, where corrective actions can be taken upon submission of POs reports in the course's teaching file. In addition, the Department has the macro level view of the POs achievement in every phase.
- CQI purpose. The lecturer and programme coordinator can perform CQI tasks to improve the POs achievement as the students progress towards the next phase. The CQI process is crucial before the final year (Phase 3).

For the first phase, the analysis combines both first and second year academic calendars. The combination is done because most of the courses offered during the first two years are mostly faculty and university related courses, which are introductory courses and include few EE programme-related courses. Hence, there will be insufficient POs assessment if evaluation is done separately for each academic calendar year for the first year and second year students. By combining both of the academic years, courses assessment covers all of the POs.

The three phases involved to represent the POs achievement can be summarised as follow:

1. Phase 1: combination of first and second academic years, mostly covering faculty and university level courses.
2. Phase 2: third academic year, which covers some programme level courses.
3. Phase 3: fourth academic year, which covers the majority of the programme level courses.

As for the indirect assessment, SSA is used as a tool to measure the POs indirectly. It is implemented in order to assess the students' perception of how well they have achieved the specified COs in the course, i.e. a comparison between before and after during the lecture weeks. SSA assessment is implemented in two stages: a) entry SSA, implemented at the first week of the semester; and b) exit SSA, assessment during the final lecture week (14th week). It is implemented in such a way that the students' perception, after they have gone through several assessment methods during the lecture weeks (from the first week until the final lecture week) can be used as a comparison.

For the evaluation of both direct and indirect measurements, several EE courses offered in Semester 1 and Semester 2 for the 2011/2012 academic year were selected in this study, as summarised in Table 1. To ensure consistency, courses selected for indirect measurement are sub-set courses in direct measurement and due to time limitations, not all the SSA survey forms could be distributed to the students.

Table 1: Courses involved in the POs assessment for the EE programme.

Year	Number of courses	
	Direct measurement	Indirect measurement
1 and 2 (Phase 1)	11	9
3 (Phase 2)	12	6
4 (Phase 3)	9	7
Total	32	22

LEVEL OF POs ACHIEVEMENT

The mapping and the interpretation of the level of POs achievement in relation to the students' scores are shown in Table 2.

The scores are mapped to an equivalent score point average (SPA). SPA can be defined as a measure of the student's POs achievement. SPA is represented by a numerical calculation that indicates where an average of the grades is measured on a scale from 0 to 5, with a corresponding cumulative grade point average (CGPA), ranging from the highest CGPA 4.00 to the lowest CGPA 0.00.

It can be seen that there is a direct relationship between the SPA and the student's CGPA performance to evaluate fairly the student's POs achievement. A SPA of 2.5 or above (equivalent to CGPA $\geq$ 2.00) is used as a benchmark on whether or not the targeted POs were achieved.

Table 2: Grading scale and associated level of achievement of the designated POs.

Score point average	CGPA	Level of achievement of the designated POs
5.00	4.00	Excellent
$\geq$ 3.75	$\geq$ 3.00	Good
$\geq$ 2.50	$\geq$ 2.00	Average (or Pass)
< 2.50	< 2.00	Poor

DIRECT POs ASSESSMENT BASED ON PHASES

Figure 2 shows the formative POs achievement based on different phases. There are gradual improvements in some of the POs (PO1 and PO2), while there are minor variations for the rest of the POs achievement. The variations can be explained by the increase in difficulty level in the cognitive domain from the first phase to the third phase.

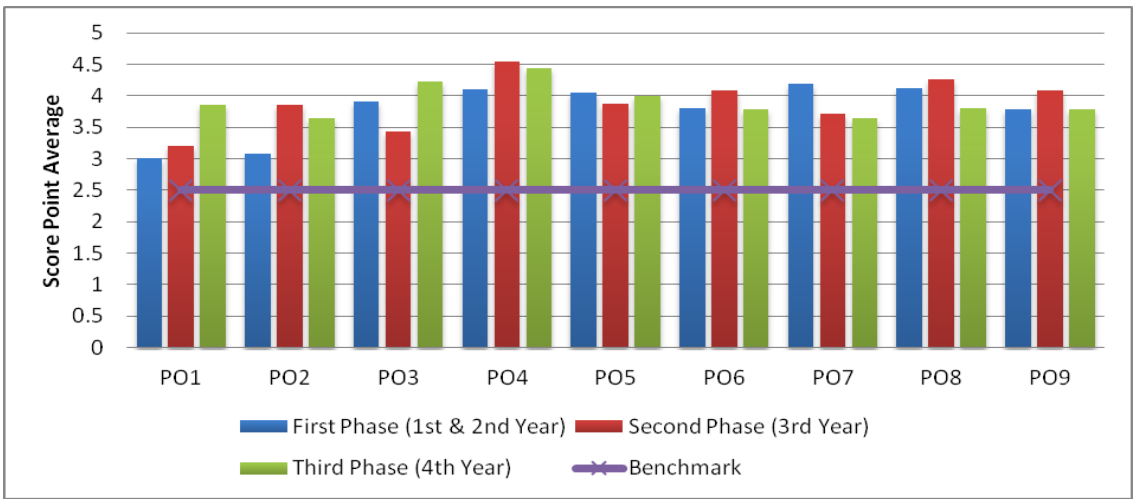

Figure 2: Students' performance based on direct POs assessment.

DIRECT POs ASSESSMENT BASED ON COHORT

The main motivation behind the POs assessment based on a cohort is to evaluate the improvement of the students as they progress towards the end of the academic year. For this analysis, the cohort was selected from the batch of third year students in 2010/2011 and, which later became the fourth year students in the 2011/2012 academic intake.

The POs achievement for this cohort is shown in Figure 3. In general, the selected cohort met the targeted POs achievement. There were noticeable improvements in some of the POs, while there was some degradation of the POs performance, although the difference is relatively small.

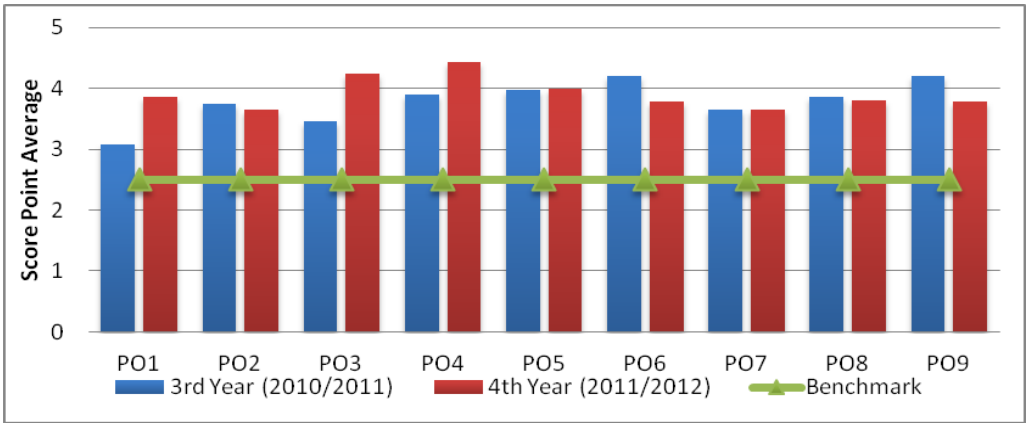

Figure 3: Students' formative POs achievement based on the cohort.

INDIRECT MEASUREMENT: STUDENT'S SELF-ASSESSMENT

The evaluation of the students' perception between entry and exit are presented in Figure 4. The benchmarking for the SPA is set at 2.50 (as in Table 1). From Figure 4, it can be seen that the students have exceeded the SPA expectation at the final lecture week based on the SSA exit results. This observation is opposite to the SSA entry score.

This result is expected as the students show high confidence levels as they have undertaken different assessments and delivery methods related to the course, such as group discussions, tutorials, assignments, projects and a mid semester examination. It can also be seen that the SSA achievement for the third phase is the lowest, compared with the other phases, which suggests that the final year students' expectation is very low, although they have undertaken the pre-requisite subjects during the first and second phases.

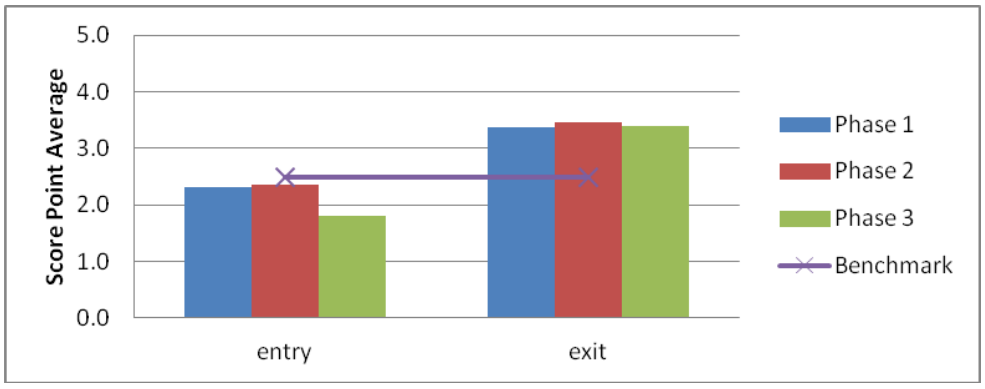

Figure 4: SSA comparisons between entry and exit for different phase.

RELATIONSHIP BETWEEN DIRECT AND INDIRECT MEASUREMENT

Figure 5 shows the relationship between direct assessment (based on the phase from Figure 2) and indirect assessment (from the exit survey). It can be observed that the difference between both methods is small, especially for the Phase 1 intake. Thus, it can be summarised that there is a strong correlation between direct and indirect measurement.

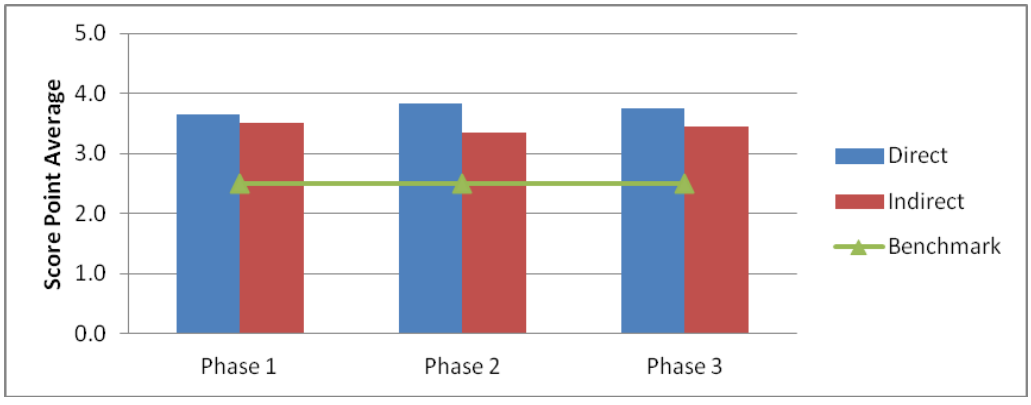

Figure 5: Relationship between direct and indirect measurement.

CONCLUDING REMARKS

The authors have used both direct and indirect forms of assessment to evaluate the POs achievement based on different dimensions. The method of assessments are: a) direct POs assessment based on phase; b) direct POs assessment based on cohort; and c) indirect measurement based on students' perceptions relating to the POs. There is a strong correlation between direct and indirect measurement. The analysis indicates that all the students have exceeded the minimum benchmark requirement for all the POs being measured. In addition, it is important to observe that the students have achieved the targeted POs.

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BIOGRAPHIES

Rosdiadee Nordin received his 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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