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# A BLUEPRINT OF SOFTWARE ENABLED QUANTITATIVE MEASUREMENT OF PROGRAMME OUTCOMES: A CASE STUDY FOR TAYLOR'S UNIVERSITY

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**Abstract**

Lecturers are fully occupied with many tasks including preparing teaching materials, exam papers, lab sheets, markings, research, and administrative support tasks required of them to maintain high standard teaching delivery and good quality management system in the school. Aside from these, they are now required to do intensive Outcome-Based Education (OBE) assessments, and Continual Quality Improvement (CQI) planning and implementation. An automated OBE assessment tool is therefore required to ease the burden among the lecturers and provide a standard method of assessment. To assist in this process, this paper presents a blueprint of a software-enabled quantitative measurement of the Learning Outcomes (LO) and the Programme Outcomes (PO) in the module level. The blueprint consists of macro-enabled worksheets that automatically calculate the students' individual LO and PO attainments based on their respective module assessment marks whereby the lecturer only need to key-in the subject details of assessments-LO mapping, LO-PO mapping and the students' assessment marks. Once the marks are in place, LO and PO attainments are calculated automatically to provide the corresponding bar charts based on the individual attainments of the students. A LO or a PO is said to be attained when the number of students achieved the Key Performance Index (KPI) set by the department. The results will then be used by the lecturer to prepare an annual module review and prepare a CQI plan for the next semester.

Keywords: Outcome-based education, Outcomes, Key performance index, LO attainment, PO attainment.

## 1. Introduction

The Washington Accord (WA) is an agreement signed between member countries responsible for accrediting professional engineering degree programs in each of the

signatory countries which mutually recognizes the substantial equivalency of programs accredited by these bodies based on accreditation criteria, policies and procedures that are substantially equivalent [1]. It recommends that graduates accredited by signatory members be recognized by other member countries as having substantially met the academic requirements for entry to the practice of the engineering profession [1]. In particular, Malaysia who became full signatory to the accord in 2009 tasks the Engineering Accrediting Council (EAC) to implement OBE to all engineering degree programmes as a requirement for accreditation. The EAC [2] stipulated in its 2012 manual that programme outcomes of any engineering curriculum should demonstrate a CQI culture of implementation though OBE which would bring about the expected graduate attributes.

Spady and Marshall [3] defined OBE as a transitional approach in the education system primarily concerned with the students' capabilities upon graduation and focuses curriculum and assessments design around higher-order exit outcomes. It is a shift from the traditional approach where the emphasis is on inputs and resources to an outcome-based system maximizing the students' performance capabilities [4].

Aligning to this OBE concept, the EAC manual [2] pictured its OBE policies to guide IHLs in running degree programmes as modelled in Fig. 1 [5].

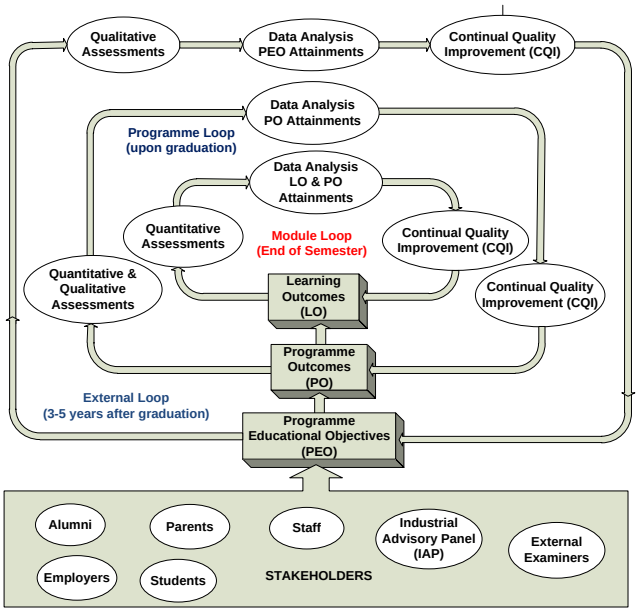


**Fig. 1. The OBE Model.**

With reference to Fig. 1, the module loop is a continuous cycle of quantitative assessments, LO and PO attainment analysis (taking into account effect of the previous CQI implementation), and the current CQI plan. The LO assessments will provide information on which LO and PO did not satisfy the target KPI. Further analysis will result to identifying the gaps in the students' learning process based on set learning outcomes. Results will be used to prepare a CQI plan intended to be implemented for the next semester. In the programme loop, all

courses taken by the cohort of students will be subjected to end of semester PO assessment to determine which PO did not meet the target KPI. Results will also reveal the lacks and insufficiencies of programme delivery. The external loop will focus on qualitative assessments of the Programme Educational Objective (PEO) 3 – 5 years after graduation to close the loop of the CQI process.

A number of literatures about OBE had been presented in recent years but details of its quantitative assessment schemes are quite limited. Young et al. [6] conducted an OBE assessment to determine the PO attainment level of their engineering programmes. Their findings suggest that OBE assessments should start in the module level to determine the gaps in the learning process and be able to do corrective measures to improve attainment level. As suggested by Deng et al. [7] and EAC [2] programme outcomes should focus on basic engineering attributes such as knowledge, skills, and attitudes in order to be job-ready graduates. They further stressed the use of appropriate key-word in the learning outcomes to ensure depth module assessments.

Authorities in OBE have not concretely defined the OBE assessment standards which leads to various methods and techniques being used in many universities. In Malaysia particularly, Ismail et al. [8] reported that in Universiti Kebangsaan Malaysia (UKM), an used grade point average (GPA) at the end of semester to assess OBE, while Sani et al. [9] stated that Universiti Malaysia (UM) Pahang used an exit survey from final year students to assess the PO attainments of its mechanical engineering programme for CQI planning and implementation. In Universiti Putra Malaysia (UPM), Jaafar et al. [10] reported that the Faulty of Engineering needed to use an office automation system to handle the voluminous data generated by the programmes for OBE assessment. In the PO assessment, each PO was given different level of emphasis for a given module to ensure better reliability and accuracy.

As OBE is a continuous, and a tedious process, lecturers are faced by added burden of preparing documents to evaluate the students' LO and PO attainments for each module. This is on top of a module analysis and CQI plan to be prepared and presented based on LO and PO results. As lecturers are already tied-up with a lot of paper documentation for each module required by the accrediting agency, there is an urgent need to provide a blueprint of software-enabled quantitative measurements of LO and PO attainments.

## 2. End of Semester Assessment Tool (ESAT)

The OBE assessment tool developed by the author consists of macro-enabled excel worksheets that focuses on end of semester LO and PO assessments in the module level. This improved model was implemented at by the School of Engineering in all of its engineering programmes. The implementation of ESAT is shown in Fig. 2.

As shown in Fig. 2, the LO-PO assessment flow starts with the Scheme of Work (SOW) prepared by each lecturer before the start of each semester. The SOW contains the details of Assessment Components (AC) and their respective mapping to each LO, and the LO-PO mapping among others. These informations will then be used to generate the LO-PO mapping and the associated normalized LO and PO marks. The students' raw marks for all defined assessment

components were used as input to generate the expected actual maximum normalized marks for each assessment component. Subsequently, the respective LO and PO attainment results for each student will be generated to serve as basis in generation the class LO and PO attainments. A student is said to attain a particular LO if his assessment mark related to that LO is greater than or equal to the set KPI. A student is said to attain a particular PO if his assessment mark related to that PO is greater than or equal to the set KPI. The module's LO and PO attainment are based on the number of students achieving KPI. ESAT detail is hereby presented as follows:

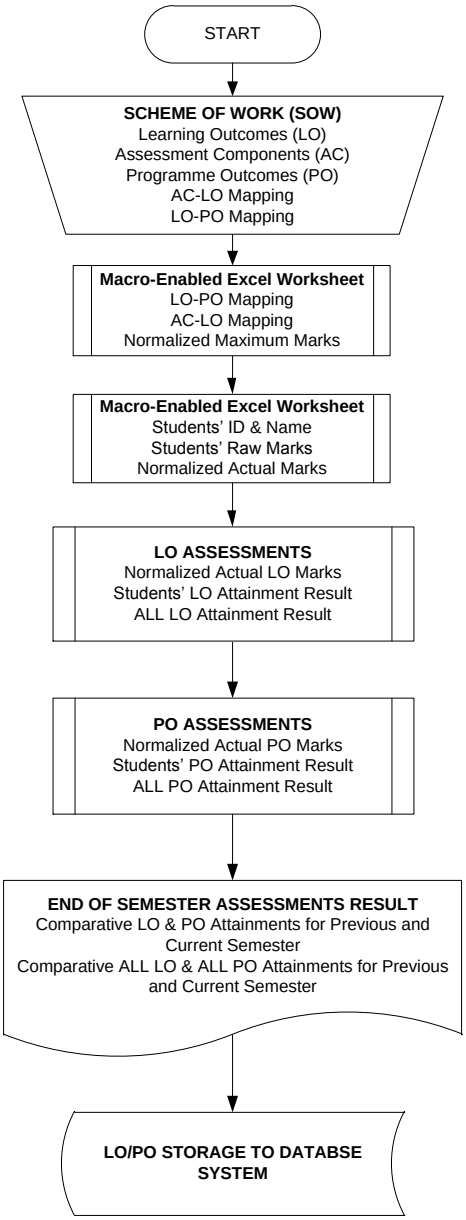


**Fig. 2. Taylor's LO-PO Assessments Flow.**

## 2.1. ESAT – Initialization

To start a new assessment, the lecturer should press the "RESET CONTENTS" button to reset all existing system data. This is followed by selecting the programme where the module is attached. The screenshots is shown in Fig. 3. The system is now ready to receive inputs for new assessment.

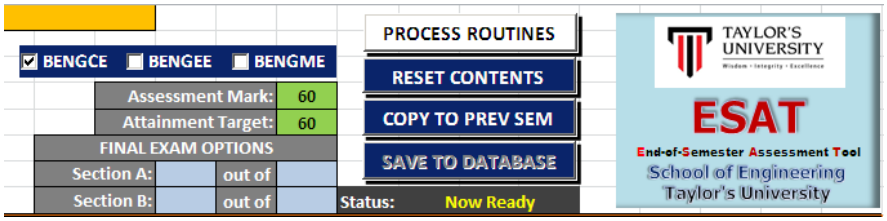


**Fig. 3. Initialization.**

In Fig. 3, once the programme is selected, the lecturer needs to key-in the module details – module code, module title, assessment semester, and the module lecturer. A screenshot is shown in Fig. 4.

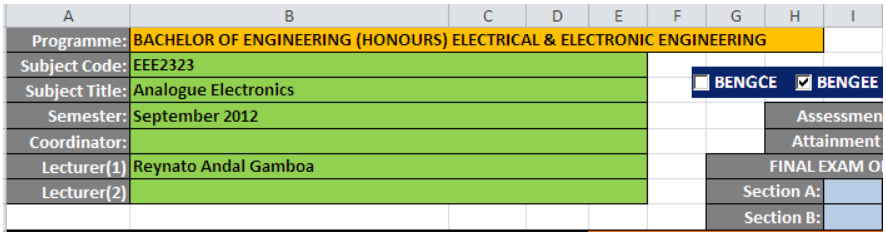


**Fig. 4. Module Details.**

## 2.2. ESAT – LO-PO Mapping

Objective mapping of the LO to PO should be undertaken to ensure that assessments will be reflective of the desired results. Mapping of LO-PO based on the SOW prepared at the beginning of semester is shown in Table 1.

**Table 1. Learning Outcomes (LO) – Programme Outcomes (PO) Mapping.**

| MAPPING MUST BE BASED ON THE SCHEME OF WORK (SOW) | | LO-PO MAPPING | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| INSTRUCTION: | EDIT GREEN-COLORED CELLS ONLY. | PROGRAMME OUTCOMES (PO) | | | | | | | | | | | | | | | | TOTAL |
| CODE | LEARNING OUTCOMES (LO) | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PO13 | PO14 | PO15 | | PO's |
| LO1 | Design rectifier and filter circuits | x | x | | | | | | | | x | | | | | | | 3 |
| LO2 | Design and analyze BJT and FET amplifier circuits | x | x | | | | | | | | x | | | | | | | 3 |
| LO3 | Design and analyze power amplifier circuits | x | | | x | | | | | | | | | | | | | 2 |
| LO4 | Explain configurations of op-amp circuits and build a range | x | | | x | | x | | | | | | | | | | | 3 |
| LO5 | Classify feedback amplifier circuits and implement stability | x | | | x | | x | | | | | | | | | | | 3 |
| LO6 | Analyse different types of oscillator circuits | x | | | x | | | | | | | | | | | | | 2 |
| LO7 | | | | | | | | | | | | | | | | | | |

In Table 1, the LO-PO mapping was based on the module to PO mapping set and approved by the department. For simplicity, each mapped PO was given equal emphasis. Other universities used emphasis in mapping LO-PO using say 1, 2, or 3 for low, medium, and high emphasis, respectively. This will give added burden to the Lecturers. Comparison of sampling results using emphasis of say 1,

2, or 3 as mentioned with that of equal emphasis employed in this blueprint produced insignificant difference.

## 2.3. ESAT – Assessment Components (AC) - LO Mapping

Based on SOW, the details of AC-LO mapping was laid out. This section allows the lecturer the flexibility to key-in the mapping details according to his preference. Table 2 show the screenshot of the AC-LO mapping.

In Table 2, Column C is the overall raw percentage of each assessment components while column D is the calculated actual percentage of each component based on defined mapping. The total allotted marks for each assessment components need not be 100 marks since these are normalized to 100 automatically. Screenshots are shown in Tables 3 and 4 respectively.

The total normalized marks were used to estimate the normalized PO marks based on the LO-PO mapping of Table 1. Those total LO and PO marks were then used to calculate the student's LO and PO attainments. Equation 1 shows how the PO normalized marks are calculated:

**Table 2. AC-LO and LO-PO Mapping.**

| | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 26 | MAPPING MUST BE BASED ON EXAM MODERATION FORM (EMF) | | | | ASSESSMENTS-LO MAPPING | | | | | | | | | | | | |
| 27 | INSTRUCTION: | EDIT GREEN-COLORED CELLS ONLY. | % MARKS | | ASSESSMENTS' FULL MARKS | | | | | | | | | | | | TOTAL |
| 28 | CODE | ASSESSMENT COMPONENTS | OVERALL | ACTUAL | LO1 | LO2 | LO3 | LO4 | LO5 | LO6 | LO7 | LO8 | LO9 | LO10 | LO11 | LO12 | MARKS |
| 29 | T1 | Test 1-Q1 | 10.0% | 2.5% | 20.0 | | | | | | | | | | | | 20.0 |
| 30 | T1 | Test 1-Q2 | | 2.5% | 20.0 | | | | | | | | | | | | 20.0 |
| 31 | T1 | Test 1-Q3 | | 2.5% | | 20.0 | | | | | | | | | | | 20.0 |
| 32 | T1 | Test 1-Q4 | | 2.5% | | 20.0 | | | | | | | | | | | 20.0 |
| 33 | T2 | Test 2-Q1 | 10.0% | 3.1% | | | 25.0 | | | | | | | | | | 25.0 |
| 34 | T2 | Test 2-Q2 | | 1.9% | | | 15.0 | | | | | | | | | | 15.0 |
| 35 | T2 | Test 2-Q3 | | 2.5% | | | | 20.0 | | | | | | | | | 20.0 |
| 36 | T2 | Test 2-Q4 | | 2.5% | | | | 20.0 | | | | | | | | | 20.0 |
| 37 | L1 | Lab 1 | 5.0% | 5.0% | 100.0 | | | | | | | | | | | | 100.0 |
| 38 | L2 | Lab 2 | 5.0% | 5.0% | | 100.0 | | | | | | | | | | | 100.0 |
| 39 | F | Finals-Q1 | 70.0% | 10.5% | 15.0 | | | | | | | | | | | | 15.0 |
| 40 | F | Finals-Q2 | | 10.5% | | 15.0 | | | | | | | | | | | 15.0 |
| 41 | F | Finals-Q3 | | 10.5% | | | 15.0 | | | | | | | | | | 15.0 |
| 42 | F | Finals-Q4 | | 10.5% | | | | | 15.0 | | | | | | | | 15.0 |
| 43 | F | Finals-Q5 | | 14.0% | | | | 20.0 | | | | | | | | | 20.0 |
| 44 | F | Finals-Q6 | | 14.0% | | | | | | 20.0 | | | | | | | 20.0 |
| 45 | | | | | | | | | | | | | | | | | |
| 46 | | | | | | | | | | | | | | | | | |

**Table 3. Actual Normalized LO Marks.**

| | O | P | Q | R | S | T | U | V | W | X | Y | Z | AA | AB | AC | AD | AE | AF |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 26 | | | | | | | | | | | | | | | | | | |
| 27 | | | TOTAL | TOTAL | | NORMALIZED LO MARKS | | | | | | | | | | | | |
| 28 | LO11 | LO12 | MARKS | LO's | | LO1 | LO2 | LO3 | LO4 | LO5 | LO6 | LO7 | LO8 | LO9 | LO10 | LO11 | LO12 | TOTAL |
| 29 | | | 20.0 | 1 | | 2.50 | | | | | | | | | | | | 2.50 |
| 30 | | | 20.0 | 1 | | 2.50 | | | | | | | | | | | | 2.50 |
| 31 | | | 20.0 | 1 | | | 2.50 | | | | | | | | | | | 2.50 |
| 32 | | | 20.0 | 1 | | | 2.50 | | | | | | | | | | | 2.50 |
| 33 | | | 25.0 | 1 | | | | 3.13 | | | | | | | | | | 3.13 |
| 34 | | | 15.0 | 1 | | | | 1.88 | | | | | | | | | | 1.88 |
| 35 | | | 20.0 | 1 | | | | | 2.50 | | | | | | | | | 2.50 |
| 36 | | | 20.0 | 1 | | | | | 2.50 | | | | | | | | | 2.50 |
| 37 | | | 100.0 | 1 | | 5.00 | | | | | | | | | | | | 5.00 |
| 38 | | | 100.0 | 1 | | | 5.00 | | | | | | | | | | | 5.00 |
| 39 | | | 15.0 | 1 | | 10.50 | | | | | | | | | | | | 10.50 |
| 40 | | | 15.0 | 1 | | | 10.50 | | | | | | | | | | | 10.50 |
| 41 | | | 15.0 | 1 | | | | 10.50 | | | | | | | | | | 10.50 |
| 42 | | | 15.0 | 1 | | | | | | 10.50 | | | | | | | | 10.50 |
| 43 | | | 20.0 | 1 | | | | | 14.00 | | | | | | | | | 14.00 |
| 44 | | | 20.0 | 1 | | | | | | | 14.00 | | | | | | | 14.00 |
| 45 | | | | | | | | | | | | | | | | | | |
| 46 | | | | | | | | | | | | | | | | | | |
| 47 | | | | | | | | | | | | | | | | | | |
| 48 | | | | 16 | | 20.50 | 20.50 | 15.51 | 19.00 | 10.50 | 14.00 | | | | | | | 100.01 |

**Table 4. Actual Normalized PO Marks.**

| | R | S | T | U | V | W | X | Y | Z | AA | AB | AC | AD | AE | AF | AG | AH | AI | AJ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9 | | | | | | | | | | | | | | | | | | | |
| 10 | | | TOTAL | | NORMALIZED ATTAINMENT MARKS | | | | | | | | | | | | | | |
| 11 | PO14 | PO15 | PO's | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PO13 | PO14 | PO15 |
| 12 | | | 3 | | 6.83 | 6.83 | | | | | | | | 6.83 | | | | | |
| 13 | | | 3 | | 6.83 | 6.83 | | | | | | | | 6.83 | | | | | |
| 14 | | | 2 | | 7.76 | | | 7.76 | | | | | | | | | | | |
| 15 | | | 3 | | 6.33 | | | 6.33 | | 6.33 | | | | | | | | | |
| 16 | | | 3 | | 3.50 | | | 3.50 | | 3.50 | | | | | | | | | |
| 17 | | | 2 | | 7.00 | | | 7.00 | | | | | | | | | | | |
| 18 | | | | | | | | | | | | | | | | | | | |
| 19 | | | | | | | | | | | | | | | | | | | |
| 20 | | | | | | | | | | | | | | | | | | | |
| 21 | | | | | | | | | | | | | | | | | | | |
| 22 | | | | | | | | | | | | | | | | | | | |
| 23 | | | | | | | | | | | | | | | | | | | |
| 24 | | | 6 | | 38.25 | 13.66 | | 24.59 | | 9.83 | | | | 13.66 | | | | | |

$$PO\ Share = \frac{Total\ Normalized\ LO}{No.\ of\ PO's\ mapped\ to\ LO} \quad (1)$$

Applying Eq. (1) to Table 4, and using Tables 1 and 3,

$$PO1\ Share = \frac{LO1\ Share\ (Table\ 3, row\ 48)}{No.\ of\ PO's\ mapped\ (Table\ 1, column\ T} = \frac{20.5}{3} = 6.83$$

Equation (1) was used to fill up Table 4. The sum total of all PO shares constitutes the maximum PO attainment marks expected of the students to attain.

## 2.4. Students Raw Marks

The next input from Lecturers is the students' raw marks for each assessment components which automatically convert them into actual normalized marks. Sample data input is shown in Table 5.

**Table 5. Students' Raw Assessment Marks.**

| | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 61 | INSTRUCTION: | CLICK ME→ | HEADING LAYOUT | | | | | | | | | | | | | | | | |
| 62 | | | | | | | | | | | | | | | | | | | |
| 63 | | | UPDATE LO/PO | | | | | | | | | | | | | | | | |
| 64 | EDIT THE GREEN-COLORED CELLS ONLY. | | | | | | | | | | | | | | | | | | |
| 65 | LO and PO ATTAINMENT RESULTS WILL BE | | | | | | | | | | | | | | | | | | |
| 66 | GENERATED AUTOMATICALLY. | | | | | | | | | | | | | | | | | | |
| 67 | PLEASE KEY-IN THE STUDENT'S RAW MARKS | | Test 1-Q1 | Test 1-Q2 | Test 1-Q3 | Test 1-Q4 | Test 2-Q1 | Test 2-Q2 | Test 2-Q3 | Test 2-Q4 | Lab 1 | Lab 2 | Final-Q1 | Final-Q2 | Final-Q3 | Final-Q4 | Final-Q5 | Final-Q6 | |
| 68 | IN EACH ASSESSMENT COMPONENTS. | | | | | | | | | | | | | | | | | | |
| 69 | | MAXIMUM NORMALIZED MARKS: | 2.5 | 2.5 | 2.5 | 2.5 | 3.1 | 1.9 | 2.5 | 2.5 | 5.0 | 5.0 | 10.5 | 10.5 | 10.5 | 10.5 | 14.0 | 14.0 | |
| 70 | STUDENT | MAXIMUM RAW MARKS: | 20.0 | 20.0 | 20.0 | 20.0 | 25.0 | 15.0 | 20.0 | 20.0 | 100.0 | 100.0 | 15.0 | 15.0 | 15.0 | 15.0 | 20.0 | 20.0 | |
| 71 | NUMBER | COVERED LO's | LO1 | LO1 | LO2 | LO2 | LO3 | LO3 | LO4 | LO4 | LO1 | LO2 | LO1 | LO2 | LO3 | LO5 | LO4 | LO6 | |
| 72 | 00001 | Name of Student #1 | 20.0 | 12.0 | 20.0 | 15.0 | 25.0 | 12.0 | 5.0 | 10.0 | 78.0 | 88.0 | 15.0 | 10.0 | 6.0 | 11.0 | 10.0 | 14.0 | |
| 73 | 00002 | Name of Student #2 | 20.0 | 11.0 | 20.0 | 20.0 | 25.0 | 15.0 | 20.0 | 20.0 | 89.0 | 89.0 | 15.0 | 15.0 | 14.0 | 12.0 | 14.0 | 20.0 | |
| 74 | 00003 | Name of Student #3 | 20.0 | 5.0 | 20.0 | 15.0 | 3.0 | 4.0 | 5.0 | 7.0 | 82.0 | 90.0 | 8.0 | 14.0 | 9.0 | 15.0 | 18.0 | 13.0 | |
| 75 | 00004 | Name of Student #4 | 12.0 | 1.0 | 3.0 | 1.0 | 13.0 | 2.0 | 0.0 | 0.0 | 88.0 | 90.0 | 1.0 | 4.0 | 5.0 | 0.0 | 11.0 | 19.0 | |
| 76 | 00005 | Name of Student #5 | 16.0 | 12.0 | 20.0 | 16.0 | 19.0 | 15.0 | 20.0 | 20.0 | 77.0 | 82.0 | 10.0 | 15.0 | 9.0 | 10.0 | 15.0 | 16.0 | |
| 77 | 00006 | Name of Student #6 | 19.0 | 8.5 | 20.0 | 15.0 | 25.0 | 15.0 | 20.0 | 20.0 | 95.0 | 91.0 | 6.0 | 13.0 | 8.0 | 11.0 | 17.0 | 20.0 | |
| 78 | 00007 | Name of Student #7 | 15.0 | 4.0 | 20.0 | 20.0 | 21.0 | 10.0 | 7.0 | 20.0 | 95.0 | 86.0 | 15.0 | 14.0 | 12.0 | 11.0 | 7.0 | 16.0 | |
| 79 | 00008 | Name of Student #8 | 18.0 | 8.0 | 15.0 | 20.0 | 25.0 | 5.0 | 20.0 | 11.0 | 83.0 | 91.0 | 10.0 | 15.0 | 11.0 | 12.0 | 15.0 | 20.0 | |
| 80 | 00009 | Name of Student #9 | 14.0 | 1.0 | 6.0 | 6.0 | 25.0 | 10.0 | 20.0 | 3.0 | 87.0 | 84.0 | 7.0 | 13.0 | 12.0 | 13.0 | 13.0 | 19.0 | |
| 81 | 00010 | Name of Student #10 | 18.0 | 10.0 | 20.0 | 18.0 | 25.0 | 15.0 | 13.0 | 20.0 | 79.0 | 89.0 | 11.0 | 13.0 | 15.0 | 12.0 | 16.0 | 20.0 | |
| 82 | 00011 | Name of Student #11 | 18.0 | 4.0 | 12.0 | 14.0 | 15.0 | 3.0 | 5.0 | 6.0 | 85.0 | 88.0 | 6.0 | 11.0 | 4.0 | 4.0 | 14.0 | 0.0 | |
| 83 | 00012 | Name of Student #12 | 5.0 | 2.0 | 20.0 | 20.0 | 17.0 | 8.0 | 20.0 | 2.0 | 88.0 | 72.0 | 0.0 | 7.0 | 6.0 | 0.0 | 15.0 | 20.0 | |

From the layout of Table 5, there are quite a number of information that could be derived which include marks distribution breakdown, total marks and equivalent grade, LO and PO attainments per student, and all LO and all PO attainments among others. The data gathered can be used to do a thorough

module analysis to identify the gaps and insufficiencies in the module delivery as well as the individual student's performance.

## 2.5. Students' LO Attainments Result

After completing Table 5, the LO attainment marks were then computed automatically based on the normalized LO marks. Table 6 shows the resulting students' LO attainment marks. The resulting LO attainments are shown in Table 7.

**Table 6. Students' LO Attainment Marks.**

INSTRUCTION: CLICK ME→ HEADING LAYOUT / UPDATE LO/PO

EDIT THE GREEN-COLORED CELLS ONLY.
LO and PO ATTAINMENT RESULTS WILL BE GENERATED AUTOMATICALLY.
PLEASE KEY-IN THE STUDENT'S RAW MARKS IN EACH ASSESSMENT COMPONENTS.

| # of Students attained ALL LO | | |
|---|---|---|
| Intake Semester | Yes | No |
| April 2012 Semester | 11.1 | 88.9 |
| September 2012 Semester | 36.8 | 63.2 |

| STUDENT NUMBER | COVERED LO's | # Students TOTAL | GRADE | LO1 | LO2 | LO3 | LO4 | LO5 | LO6 | LO7 | LO8 | LO9 | LO10 | LO11 | LO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MAXIMUM NORMALIZED MARKS: | 19 | | | | | | | | | | | | | |
| | MAXIMUM RAW MARKS: | | | 20.50 | 20.50 | 15.51 | 19.00 | 10.50 | 14.00 | | | | | | |
| 000001 | Name of Student #1 | 69 | B | 18.4 | 15.8 | 8.8 | 8.9 | 7.7 | 9.8 | | | | | | |
| 000002 | Name of Student #2 | 91 | A | 18.8 | 20.0 | 14.8 | 14.8 | 8.4 | 14.0 | | | | | | |
| 000003 | Name of Student #3 | 72 | B+ | 12.8 | 18.7 | 7.2 | 14.1 | 10.5 | 9.1 | | | | | | |
| 000004 | Name of Student #4 | 41 | D- | 6.7 | 7.8 | 5.4 | 7.7 | | 13.3 | | | | | | |
| 000005 | Name of Student #5 | 78 | A- | 14.4 | 19.1 | 10.6 | 15.5 | 7.0 | 11.2 | | | | | | |
| 000006 | Name of Student #6 | 80 | A | 12.4 | 18.0 | 10.6 | 16.9 | 7.7 | 14.0 | | | | | | |
| 000007 | Name of Student #7 | 76 | A- | 17.6 | 19.1 | 12.3 | 8.3 | 7.7 | 11.2 | | | | | | |
| 000008 | Name of Student #8 | 82 | A | 14.4 | 19.4 | 11.5 | 14.4 | 8.4 | 14.0 | | | | | | |
| 000009 | Name of Student #9 | 73 | B+ | 11.1 | 14.8 | 12.8 | 12.0 | 9.1 | 13.3 | | | | | | |
| 000010 | Name of Student #10 | 87 | A | 15.2 | 18.3 | 15.5 | 15.3 | 8.4 | 14.0 | | | | | | |
| 000011 | Name of Student #11 | 46 | D | 11.2 | 15.4 | 5.1 | 11.2 | 2.8 | | | | | | | |
| 000012 | Name of Student #12 | 53 | C | 5.3 | 13.5 | 7.3 | 13.2 | | 14.0 | | | | | | |

**Table 7. Students' LO Attainments Result.**

TAYLOR'S UNIVERSITY
SCHOOL OF ENGINEERING
BACHELOR OF ENGINEERING (HONOURS) ELECTRICAL & ELECTRONIC ENGINEERING

LEARNING OUTCOMES (LO) ATTAINMENT RESULTS

(A LO is considered attained if at least 60% of the students obtain at least 60% of their assessment marks related to that LO.)

| | Previous Semester: April 2012 Semester | | | Present Semester: September 2012 Semester | | |
|---|---|---|---|---|---|---|
| | LO Statements | Results | | LO Statements | Results | |
| LO1 | Design rectifier and filter circuits | No | 33.3 | Design rectifier and filter circuits | No | 57.9 |
| LO2 | Design and analyze BJT and FET amplifier circuits | Yes | 100.0 | Design and analyze BJT and FET amplifier circuits | Yes | 89.5 |
| LO3 | Design and analyze power amplifier circuits | No | 22.2 | Design and analyze power amplifier circuits | No | 52.6 |
| LO4 | Explain configurations of op-amp circuits and build a range of different types of op-amp circuits | Yes | 100.0 | Explain configurations of op-amp circuits and build a range of different types of op-amp circuits | No | 52.6 |
| LO5 | Classify feedback amplifier circuits and implement stability analysis | Yes | 77.8 | Classify feedback amplifier circuits and implement stability analysis | Yes | 68.4 |
| LO6 | Analyse different types of oscillator circuits | Yes | 100.0 | Analyse different types of oscillator circuits | Yes | 94.7 |
| LO7 | | N/A | N/A | | N/A | N/A |
| LO8 | | N/A | N/A | | N/A | N/A |
| LO9 | | N/A | N/A | | N/A | N/A |
| LO10 | | N/A | N/A | | N/A | N/A |
| LO11 | | N/A | N/A | | N/A | N/A |
| LO12 | | N/A | N/A | | N/A | N/A |

From Table 6, each student's LO mark is computed based on the LO shares of each assessment components.

$$LO\ Mark = \sum \frac{Raw\ Mark}{Max.Normalized\ Mark} \tag{2}$$

Using Eq. (2) to compute the LO's shown in Table 6, LO1 for student 000001 is,

$$LO1 = \frac{20}{20}x2.5 + \frac{12}{20}x2.5 + \frac{78}{100}x5.0 + \frac{15}{15}x10.5 = 18.4$$

All LO marks can be computed in similar manner. The student's LO attainment marks can be computed from equation 3 given by

$$LO\ Attainment = \frac{LO\ Mark}{Maximum\ LO\ Mark}x100 \quad (3)$$

Hence, $LO1\ Attainment = \frac{18.84}{20.50}x100 = 91.9\%$.

All LO attainments are computed in similar manner. A LO is said to be attained if the student's total assessment mark related to that LO is greater than or equal to the target KPI. In Table 7, the module LO attainment represents the number of students achieving each LO. This previous semester result was placed side-by-side with the present semester results to show the effect of CQI implementation. The comparative all LO attainments and LO attainments are presented in Figs. 5 and 6 respectively.

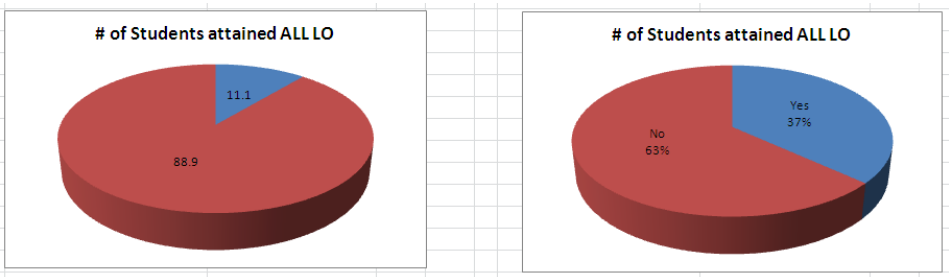


**Fig. 5. Comparison of All LO Attainment Results.**

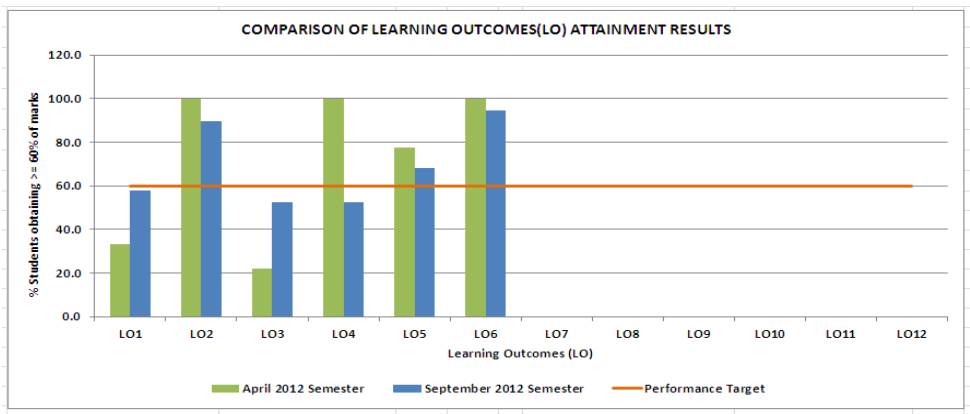


**Fig. 6. Comparison of LO Attainment Results.**

It can be noticed from Figs. 5 and 6 the improvement or lack thereof in the performance of students. This information can be used to analyze the effect of previous CQI plan that was implemented in the present semester.

## 2.6. Students PO Attainments Result

The resulting PO attainments are shown in Tables 8 and 9 respectively.

**Table 8. Students' PO Attainment Marks.**

| | A | B | BT | BU | BV | BW | BX | BY | BZ | CA | CB | CC | CD | CE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 61 | INSTRUCTION: | CLICK ME→ HEADING LAYOUT | | | | | | | | | | | | |
| 62 | | | | | | | | | | | | | | |
| 63 | | UPDATE LO/PO | | | | | | | | | | | | |
| 64 | EDIT THE GREEN-COLORED CELLS ONLY. | | | | | | | | | | | | | |
| 65 | LO and PO ATTAINMENT RESULTS WILL BE | | | | | | | | | | | | | |
| 66 | GENERATED AUTOMATICALLY. | | | | | | | | | | | | | |
| 67 | PLEASE KEY-IN THE STUDENT'S RAW MARKS | | | | | | | | | | | | | |
| 68 | IN EACH ASSESSMENT COMPONENTS. | | | | | | | | | | | | | |
| 69 | | MAXIMUM NORMALIZED MARKS: | | | | | | | | | | | | |
| 70 | STUDENT | MAXIMUM RAW MARKS: | | 38.25 | 13.66 | | 24.59 | | 9.83 | | | | 13.66 | |
| 71 | NUMBER | COVERED LO's | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
| 72 | 000001 | Name of Student #1 | | 26.2 | 11.4 | | 14.8 | | 5.5 | | | | 11.4 | |
| 73 | 000002 | Name of Student #2 | | 35.1 | 12.9 | | 22.1 | | 7.7 | | | | 12.9 | |
| 74 | 000003 | Name of Student #3 | | 26.8 | 10.5 | | 16.3 | | 8.2 | | | | 10.5 | |
| 75 | 000004 | Name of Student #4 | | 16.7 | 4.8 | | 11.9 | | 2.6 | | | | 4.8 | |
| 76 | 000005 | Name of Student #5 | | 29.5 | 11.1 | | 18.4 | | 7.5 | | | | 11.1 | |
| 77 | 000006 | Name of Student #6 | | 30.6 | 10.1 | | 20.5 | | 8.2 | | | | 10.1 | |
| 78 | 000007 | Name of Student #7 | | 29.3 | 12.2 | | 17.1 | | 5.3 | | | | 12.2 | |
| 79 | 000008 | Name of Student #8 | | 31.6 | 11.3 | | 20.3 | | 7.6 | | | | 11.3 | |
| 80 | 000009 | Name of Student #9 | | 28.7 | 8.6 | | 20.1 | | 7.0 | | | | 8.6 | |
| 81 | 000010 | Name of Student #10 | | 33.8 | 11.2 | | 22.7 | | 7.9 | | | | 11.2 | |
| 82 | 000011 | Name of Student #11 | | 16.0 | 8.8 | | 7.2 | | 4.7 | | | | 8.8 | |
| 83 | 000012 | Name of Student #12 | | 21.3 | 6.3 | | 15.1 | | 4.4 | | | | 6.3 | |

| # of Students attained ALL PO | | |
|---|---|---|
| Intake Semester | Yes | No |
| April 2012 Semester | 88.9 | 11.1 |
| September 2012 Semester | 47.4 | 52.6 |

PROGRAMME OUTCOMES (PO)

For each student, the each PO mark is computed similar to Eq. (1) and using Tables 1 and 6.

$$PO1\ Mark = \frac{18.4}{3} + \frac{18.4}{3} + \frac{18.4}{3} + \frac{18.4}{3} + \frac{18.4}{3} = 26.2$$

$$PO1\ Attainment = \frac{PO1\ Mark}{Max.PO1\ Mark} x100 = \frac{26.2}{38.25} x100 = 68.5\%$$

A PO is said to be attained if the student's PO mark is greater than or equal to the target KPI. All PO attainments can be computed in similar manner. The screenshot of the module's PO attainments is shown Table 9.

**Table 9. Students' PO Attainment Result.**

TAYLOR'S UNIVERSITY
SCHOOL OF ENGINEERING
BACHELOR OF ENGINEERING (HONOURS) ELECTRICAL & ELECTRONIC ENGINEERING

PROGRAMME OUTCOMES (PO) ATTAINMENT RESULTS

(A PO is considered attained if at least 60% of the students obtain at least 60% of their assessment marks related to that PO.)

| | Previous Semester: April 2012 Semester | | | Present Semester: September 2012 Semester | | |
|---|---|---|---|---|---|---|
| | PO Statements | Results | | PO Statements | Results | |
| PO1 | Ability to think critically, logically, and analytically in applying knowledge of science and mathematics within the domain of Electrical & Electronic Engineering field. | Yes | 88.9 | Ability to think critically, logically, and analytically in applying knowledge of science and mathematics within the domain of Electrical & Electronic Engineering field; | Yes | 73.7 |
| PO2 | Ability to function competently in a laboratory setting, design and conduct experiments and simulations, making measurements, operating and calibrating technical equipment as well as critically analysing, interpreting and reporting the results. | N/A | N/A | Ability to function competently in a laboratory setting, design and conduct experiments and simulations, making measurements, operating and calibrating technical equipment as well as critically analysing, interpreting and reporting the results; | Yes | 84.2 |
| PO3 | Ability to design and improve Electrical & Electronic systems, components and processes that satisfy technical and ergonomical requirements within realistic constraints. | Yes | 88.9 | Ability to design and improve Electrical & Electronic systems, components and processes that satisfy technical and/or ergonomical requirements within realistic constraints; | N/A | N/A |
| PO4 | Ability to use modern computational tools for technical problem solving, including, computers | N/A | N/A | Ability to use modern computational tools for technical problem solving, including, computers | Yes | 73.7 |

In Table 9, result means that the number of students achieving KPI. The previous semester results was placed side-by-side with the present semester results to indicate the effect of CQI implementation. Figures 7 and 8 show the comparative performance results based on the previous and present semester.

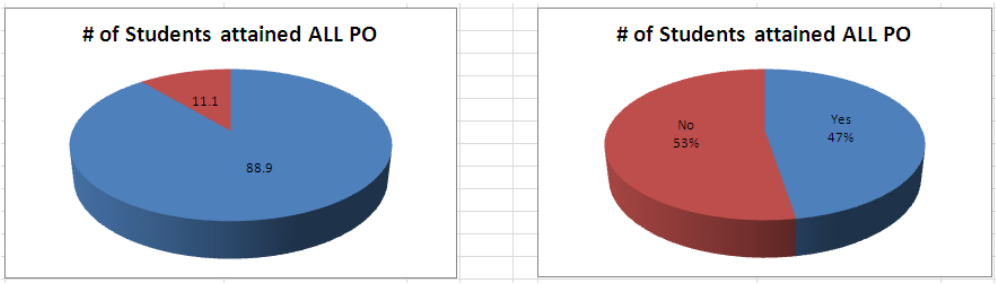


**Fig. 7. Comparison of All PO Attainment Results.**

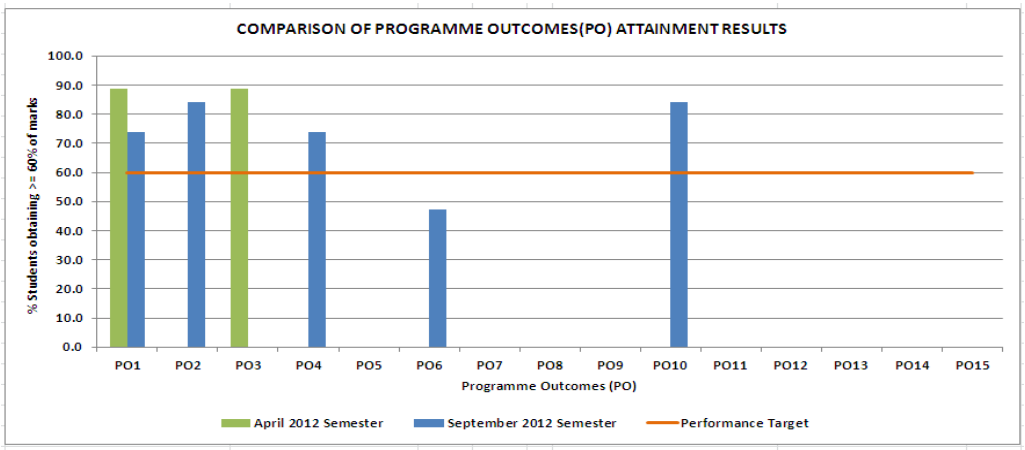


**Fig. 8. Comparison of PO Attainment Results.**

## 2.7. End-of-semester module assessment report

Based on data collected in the LO and PO assessments, module analysis should be undertaken to determine the gaps and insufficiencies in the current implementation of the CQI plan proposed during the previous semester and to propose a new CQI plan for the next semester. The detailed ESAT flow is shown in *Appendix A*.

## 3. Conclusions

A comprehensive view of the blueprint of software-enabled quantitative measurement of PO attainments had been presented. The authors believed that with this blueprint in place, Lecturers can perform module level OBE assessment with ease, reliability, and efficiency. Also, the gaps and insufficiencies in the conduct and delivery of instruction can be identified and be used to prepare a CQI

plan to further improve the module delivery. The same blueprint can also be used to develop a programme-level PO assessments to better monitor the students' periodic performance for CQI action thus ensuring better quality graduates ready to face the grand challenges of the profession.

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## *Appendix A*

## Detailed ESAT Flow.