Journal of Engineering Science and Technology
Special Issue on Engineering Education April (2013) 46 - 55

A BLUEPRINT FOR MEASURING PROGRAMME OUTCOMES

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Abstract

Programme Outcomes (POs) in the context of engineering education consists of a set of desired attributes which is to be possessed by an engineering graduate. POs are typically defined as a set of outcomes which is to be attained by an engineering graduate upon completion of the programme (or during graduation). In order to ascertain the attainment of the POs of an individual graduate, the engineering faculty can employ an array of methods to do so. Such methods are commonly placed in either quantitative or qualitative based analyses. In some cases, different types of analyses provide different results, which would render any form of discussion on PO attainment to its minimal. The present paper will highlight and discuss the important linkage of one quantitative and one qualitative method respectively employed to attain POs of an individual graduate. The result of the discussion would then be used to enhance the students overall understanding of the importance of the POs as well as to perform a self-reflection of how to address shortcomings based on POs which have not been attained.

Keywords: Programme outcomes, Quantitative, Qualitative, Portfolio.

1. Introduction

Through the implementation of Outcome Based Education (OBE) in current engineering education, this requires for engineering faculties to ascertain the attainment of relevant outcomes in an engineering programme. At the module level, a mechanism should be in place to measure the attainment of the module learning outcomes and similarly at the programme level, a mechanism to measure the attainment of the programme outcomes.

Programme outcomes are specific and measurable statements that are crafted by the engineering faculty and encapsulate the skills, knowledge and behaviour that students should acquire throughout the programme [1]. The attainment of the

POs are to be reached at the stage of graduation. POs are crafted from the Programme Educational Objectives (PEOs) of the programme. The PEOs are statements which are to be embodied by the graduate three (3) to five (5) after graduation. The PEOs in turn are crafted from the Vision and Mission of the University and hence is linked or can be mapped to the POs. POs can be crafted based on numerous ideologies or pedagogies. For example, in the Malaysian context, it is required that all POs of an engineering programme of a Malaysian institution of higher learning must be mapped to the generic POs provided by the Engineering Accreditation Council (EAC) of Malaysia (Malaysia being a signatory of the Washington Accord). The generic POs are listed below [1]

1. **Engineering Knowledge** - Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialisation to the solution of complex engineering problems;
2. **Problem Analysis** - Identify, formulate, research literature and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences;
3. **Design/Development of Solutions** - Design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations;
4. **Investigation** - Conduct investigation into complex problems using research based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions;
5. **Modern Tool Usage** - Create, select and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, to complex engineering activities, with an understanding of the limitations;
6. **The Engineer and Society** - Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice;
7. **Environment and Sustainability** - Understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate knowledge of and need for sustainable development;
8. **Ethics** - Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice;
9. **Communication** - Communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions;
10. **Individual and Team Work** - Demonstrate knowledge and understanding of engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments;
11. **Life-long Learning** - Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

12. **Project Management and Finance** - Demonstrate knowledge and understanding of engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

Using these generic POs as a guiding principle, an engineering programme may use it in the crafting of its own POs. As highlighted in [1], the authors provided a detailed explanation of how the POs of the programme were crafted based on a variety of pedagogies and ideologies including the generic POs of EAC. Based on that blueprint, the engineering programmes of Taylor's University read as follows

1. Apply the knowledge of mathematics, science, engineering practices, innovation techniques, entrepreneurship and human factors to provide value-adding solutions to complex engineering challenges.
2. Identify, formulate, analyse and document complex engineering challenges to arrive at viable solutions and substantiated conclusions.
3. Conceive, Design, Implement and Operate solutions for complex engineering challenges that meet specified requirements with appropriate consideration for public health and safety, cultural, societal, environmental and economical considerations.
4. Conduct research and investigation into complex challenges using methods which include experiment design, analysis of data and synthesis of information to provide valid conclusions.
5. Create, select and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, to complex engineering activities, with an awareness of the accompanying assumptions and limitations.
6. Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal, economical and cultural issues and the consequent responsibilities relevant to professional engineering practice.
7. Explain the global impact of professional engineering solutions in societal, economical and environmental contexts and demonstrate knowledge of and need for sustainable development.
8. Apply professional and ethical responsibilities of engineering practice.
9. Effectively communicate complex engineering activities, both orally and in a written form, in both technical & non-technical contexts.
10. Function effectively as an individual and in multidisciplinary settings with the capacity to be a leader.
11. Recognise the importance of lifelong learning and engaging in continuous professional development activities in accordance with technological change.
12. Effectively manage projects in multidisciplinary environments and apply project management tools and techniques to one's own work, as a member and leader in a team to satisfy stakeholders' requirements.

In the evaluation made by Mohammad and Zaharim [2], most of Malaysian universities modelled their PO assessments in a quantitative method where assessments were mapped to LOs and LOs are mapped to POs and used the average marks of each PO to ascertain its attainment based on defined

performance indicator. He mentioned a major weakness of this method as there is not clear performance criteria evidenced for each outcome. Rogers [3] also stressed that the focus is not a score or grade, but the student knowledge or skill that is represented by that score or grade. In is this aspect, a qualitative method of PO assessment needed to compare their respective impact on PO attainments. Thomas et al. [4] found out that portfolio-based assessment method is a viable alternative which allows the student to demonstrate specific skills within the context in which they were taught rather than within the context determined by the assessment grades.

The present paper will now discuss the methodology employed in assessing the POs from a quantitative and qualitative perspective.

2. Methodology

In order to measure the attainment of the POs of a student, Taylor's School of Engineering employed a quantitative method which calculates the PO attainment based on the LO attainment (at the module level) as LOs of all modules are mapped to the POs. This method is employed throughout the 4-year degree programme and the PO attainment of an individual student at any point in the four (4) years can be calculated.

In the 4th year of the programme (semester seven (7) out of eight (8) semesters), final year students are tasked to create and compile a PO Portfolio. This method enlists students to perform a self-assessment on what they perceive their PO attainment score to be up till that point in time. Students are given a rubric for them to make use of when determining their PO attainment score. Their perception must be appropriately substantiated with evidences throughout the four (4) years and they would then need to critically evaluate their stand and perform a gap analysis based on these perceived PO attainment scores. The students will then need to identify ways to close these gaps in the final semester of the programme which is semester eight (8).

2.1. PO Attainment Database (Quantitative)

The quantitative measurement of the programme's PO attainments is a two-step process. First, the software enabled End-of-Semester Assessment Tool (ESAT) was used to generate PO attainments of each student in the module level and stored in the database system. Second, the software-enabled database system was used to generate the Cohort's PO attainments as well as the student's PO attainments. A complete PO assessment flow is presented in Fig. 1.

In the module level, each assessment components were mapped to one more LO's and each LO is mapped to one or more PO's. For simplicity, all mapped PO's were given equal emphasis. Then each LO and PO attainment is determined according to Eqs. (1) to (4)

$$\text{LO Mark} = \sum \text{LO component mark mapped to assessment components} \quad (1)$$

$$\text{LO Attainment} = \frac{\text{LO Mark}}{\text{Maximum expected LO Mark}} \quad (2)$$

$$\text{PO Mark} = \sum \frac{\text{LO Mark mapped to the PO}}{\text{No.of PO's mapped to that LO}} \quad (3)$$

$$\text{PO Attainment} = \frac{\text{PO Mark}}{\text{Maximum expected PO Mark}} \quad (4)$$

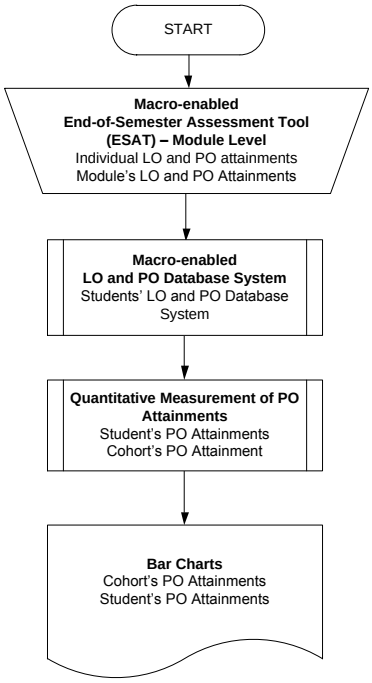

Fig. 1. Quantitative Measurement of PO Attainments.

For each student, a particular PO is said to be attained if his/her PO mark is equal to or greater than the Key Performance Index (KPI) set by the department. Consequently, the module PO attainments are based on the percent number of students achieving KPI. To illustrate the implementation of Eqs. (1) to (4), consider a screenshot from an ESAT file containing the students' components mark and the calculated LO marks based on defined mapping shown in Table 1.

To compute the LO attainment, consider LO1 for student 000001. Looking at Table 1, LO1 is mapped to Test 1-Q1, Test 1-Q2, Lab 1, and Finals-Q1. Hence, LO1 mark is computed as follows:

$$\text{LO1 Mark} = \frac{20}{20}\text{x}2.5 + \frac{12}{20}\text{x}2.5 + \frac{78}{100}\text{x}5 + \frac{15}{15}\text{x}10.5 = 18.4$$

$$\text{LO1 Attainment} = \frac{\text{LO1 Mark}}{\text{Maximum expected LO1 Mark}}\text{x}100\% = \frac{18.4}{20.5}\text{x}100\% = 89.8\%$$

If KPI is set to 60%, we say LO1 is considered attained. This procedure is repeated for all mapped LO's.

From the same ESAT file, a screenshot containing the computed LO marks and the resulting PO marks based on defined LO-PO mapping is shown in Tables 2 and 3 respectively.

Table 1. Screenshot of LO Assessment Mark from ESAT.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	AT	AU
64	EDIT THE GREEN-COLORED CELLS ONLY.																			
65	LO and PO ATTAINMENT RESULTS WILL BE																			
66	GENERATED AUTOMATICALLY.		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		
67	PLEASE KEY-IN THE STUDENT'S RAW MARKS																			
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	20.50	20.50
71	NUMBER	COVERED LO's	LO1	LO1	LO2	LO2	LO3	LO3	LO4	LO4	LO1	LO2	LO1	LO2	LO3	LO5	LO4	LO6	LO1	LO2
72	000001	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	18.4	15.8
73	000002	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	18.8	20.0
74	000003	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	12.8	18.7
75	000004	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	6.7	7.8

Table 2. Screenshot of LO-PO Mapping.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
9	MAPPING MUST BE BASED ON THE SCHEME OF WORK (SOW)				LO-PO MAPPING															Unlock
10	INSTRUCTION:	EDIT GREEN-COLORED CELLS ONLY.			PROGRAMME OUTCOMES (PO)															TOTAL
11	CODE	LEARNING OUTCOMES (LO)			PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PO's
12	LO1	Design rectifier and filter circuits			x	x								x						3
13	LO2	Design and analyze BJT and FET amplifier circuits			x	x								x						3
14	LO3	Design and analyze power amplifier circuits			x			x												2
15	LO4	Explain configurations of op-amp circuits and build a range			x			x		x										3
16	LO5	Classify feedback amplifier circuits and implement stability			x			x		x										3
17	LO6	Analyse different types of oscillator circuits			x			x												2

Table 3. Screenshot of LO-PO Assessment Marks.

	A	B	AT	AU	AV	AW	AX	AY	AZ	BA	BB	BC	BD	BE	BF
61	INSTRUCTION:	CLICK ME→ HEADING LAYOUT													
62		UPDATE LO/PO													
63					# of Students attained ALL LO										
64	EDIT THE GREEN-COLORED CELLS ONLY.				Intake Semester					Yes	No				
65	LO and PO ATTAINMENT RESULTS WILL BE				April 2012 Semester					11.1	88.9				
66	GENERATED AUTOMATICALLY.				September 2012 Semester					#REF!	#REF!				
67	PLEASE KEY-IN THE STUDENT'S RAW MARKS														
68	IN EACH ASSESSMENT COMPONENTS.		LEARNING OUTCOMES (LO) ATTAINMENT RESULTS												
69		MAXIMUM NORMALIZED MARKS:													
70	STUDENT	MAXIMUM RAW MARKS:	20.50	20.50	15.51	19.00	10.50	14.00						38.25	13.66
71	NUMBER	COVERED LO's	LO1	LO2	LO3	LO4	LO5	LO6	LO7	LO8	LO9	LO10		PO1	PO2
72	000001	Name of Student #1	18.4	15.8	8.8	8.9	7.7	9.8						26.2	11.4
73	000002	Name of Student #2	18.8	20.0	14.8	14.8	8.4	14.0						35.1	12.9
74	000003	Name of Student #3	12.8	18.7	7.2	14.1	10.5	9.1						26.8	10.5
75	000004	Name of Student #4	6.7	7.8	5.4	7.7		13.3						16.7	4.8

In similar manner, to compute the PO attainment, consider PO1 for student 000001. Looking at Table 2, PO1 is mapped to all LO's and each LO is mapped to more than one PO. In this case, PO1 is computed as the sum of the shares of each LO to PO1 divided equally among the PO's. Therefore PO1 attainment is computed from Table 2 as follows:

$$\text{PO1 Mark} = \frac{18.4}{3} + \frac{15.8}{3} + \frac{8.8}{2} + \frac{8.9}{3} + \frac{7.7}{3} + \frac{9.8}{2} = 26.2$$

$$\text{PO1 Attainment} = \frac{\text{PO1 Mark}}{\text{Maximum expected PO1 Mark}} \text{x}100\% = \frac{26.2}{38.25}\text{x}100\% = 68.5\%$$

Again, if KPI is set to 60%, we say PO1 is considered attained. This procedure is repeated for all mapped PO's.

In a programme level, after all ESAT files accumulated from semester 1 to semester 7 and stored in the ESAT database system, the cohort's PO attainments as well as each student's PO attainments can be determined according to equations 5, 6, and 7 respectively.

For each student, each PO mark is the average of the mapped PO's from all subjects taken from semester 1 to semester 7. Table 4 shows the screenshot from ESAT database system for one student with detailed modules' PO attainment marks while Table 5 shows the screenshot of the same student's average PO marks.

Table 4. Screenshot of ESAT Database System.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	2554	BENGME	Bachelor of Engineering (Honours) Mechanical Engineering											
2		CLEAR DATABASE / SEND TO DATABASE / UPDATE LIST / SETUP DATABASE; <<< FIND ME>>>	TOTAL : 219 STUDENT(S)	Intakes	ENG1113	ENG1123	ENG2113	ENG2123	ENG1213	ENG1223	ENG1233	ENG1243	ENG2223	ENG2243
3		0308130	WORKBOOKS ESATV2.1_ENG2123 2012 09 ME New.xls		3	3	3	3	3	3	3	3	3	3
110		0909B73105	ERIC TAN NAN KUI	Sep-09	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
111		ALL PO		Sep-09	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
112		KPI		Sep-09	60	60	60	60	60	60	60	60	60	60
113		PO1		Sep-09	73.2	86.7	83.6	87.6	66.1	72.0	94.4	77.9	74.7	N/A
114		PO2		Sep-09	73.2	N/A	N/A	87.6	N/A	N/A	94.4	N/A	74.5	N/A
115		PO3		Sep-09	N/A	N/A	83.6	N/A	64.7	N/A	N/A	N/A	N/A	N/A
116		PO4		Sep-09	N/A	86.7	83.6	N/A	N/A	N/A	94.4	N/A	N/A	N/A
117		PO5		Sep-09	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	76.3	N/A
118		PO6		Sep-09	N/A	86.7	83.6	N/A	65.7	72.0	94.4	81.9	82.1	98.1
119		PO7		Sep-09	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
120		PO8		Sep-09	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
121		PO9		Sep-09	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	77.0	97.4
122		PO10		Sep-09	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
123		PO11		Sep-09	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	79.5	N/A
124		PO12		Sep-09	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
125		PO13		Sep-09	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
126		PO14		Sep-09	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
127		PO15		Sep-09	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table 5. Screenshot of Student's Average PO Attainments.

	A	B	C	D	BG	BH	BI	BJ	BK	BL	BM	BN
1	2554	BENGME	Bachelor of Engineering (Honours) Mechanical Engineering		Semester 2 / Selected Subjects				Cohorts			
2		CLEAR DATABASE / SEND TO DATABASE / UPDATE LIST / SETUP DATABASE; <<< FIND ME>>>	TOTAL : 219 STUDENT(S)	Intakes	# Met KPI	# of Mapped Subjects	% # Met KPI	With "x" Mark, Ave. PO	Number Met KPI	% # of Subjects	Ave. PO Mark	Total PO Count
3		0308130	WORKBOOKS ESATV2.1_ENG2123 2012 09 ME New.xls									
110		0909B73105	ERIC TAN NAN KUI	Sep-09					N/A	N/A	N/A	N/A
111		ALL PO		Sep-09					29	90.6	91.5	32
112		KPI		Sep-09						60.0	60.0	60.0
113		PO1		Sep-09					26	92.9	76.2	28
114		PO2		Sep-09					13	81.3	76.0	16
115		PO3		Sep-09					14	82.4	72.1	17
116		PO4		Sep-09					15	93.8	78.2	16
117		PO5		Sep-09					5	83.3	76.6	6
118		PO6		Sep-09					26	92.9	78.3	28
119		PO7		Sep-09					9	90.0	72.7	10
120		PO8		Sep-09					10	83.3	71.0	12
121		PO9		Sep-09					12	92.3	77.3	13
122		PO10		Sep-09					5	83.3	70.8	6
123		PO11		Sep-09					7	87.5	71.3	8
124		PO12		Sep-09					N/A	N/A	N/A	N/A
125		PO13		Sep-09					N/A	N/A	N/A	N/A
126		PO14		Sep-09					N/A	N/A	N/A	N/A
127		PO15		Sep-09					N/A	N/A	N/A	N/A

The student's PO1 attainment is determined from the average of the modules mapped to PO1. Based on Table 5, this particular student has 28 subjects mapped to PO1 and the average PO1 mark is given by

$$\text{Average PO1 Attainment} = \frac{\sum \text{PO1 Attainment Marks}}{\text{Total no.of subjects mapped to PO1}} = 76.2$$

The corresponding bar chart is shown in Fig. 2.

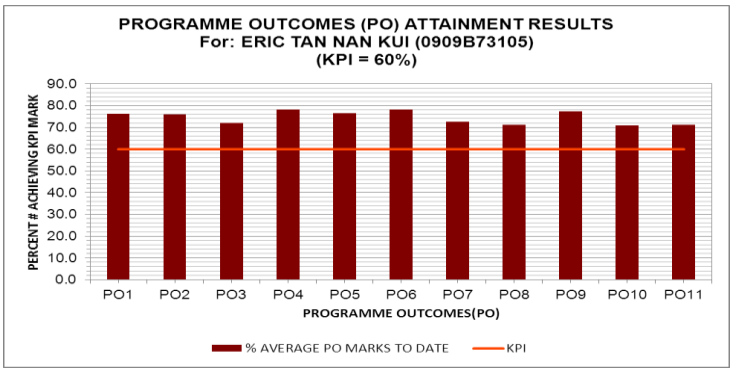

Fig. 2. PO Attainments Result of a Mechanical Engineering Student.

Using the generated PO attainments for all students similar to that of Fig. 2, the cohort's PO attainments are determined from the number of students achieving KPI based on individual student's average PO marks. For 2009 cohort of Mechanical Engineering, the PO attainments result is shown in Fig. 3.

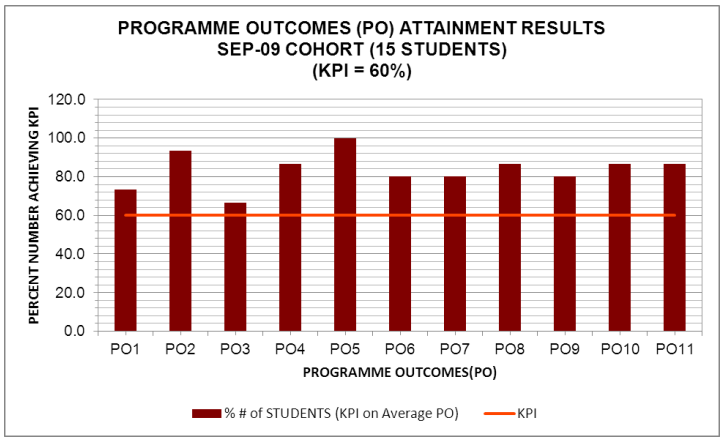

Fig. 3. 2009 Cohort PO Attainments Result (Mechanical Engineering).

2.2. PO Portfolio (Qualitative)

In the penultimate semester of the 4 year degree programme (semester 7 out of a total 8 semesters) students are tasked with creating a PO Portfolio. This portfolio details the self-assessment of the student, who will begin the process of collating the necessary evidences which would be used to evaluate their individual perception of PO attainment. Thus the student will describe and evaluate their respective PO attainment based on the evidences they have acquired. Upon the completion of this self-assessment, the portfolio is then graded by academic staff based on a detailed rubric and a score out of 10 is given for each PO. This score corresponds to the PO attainment score (qualitative).

Figure 4 below illustrates a screen shot of the PO Portfolio, while Fig. 5 describes the marking rubric used.

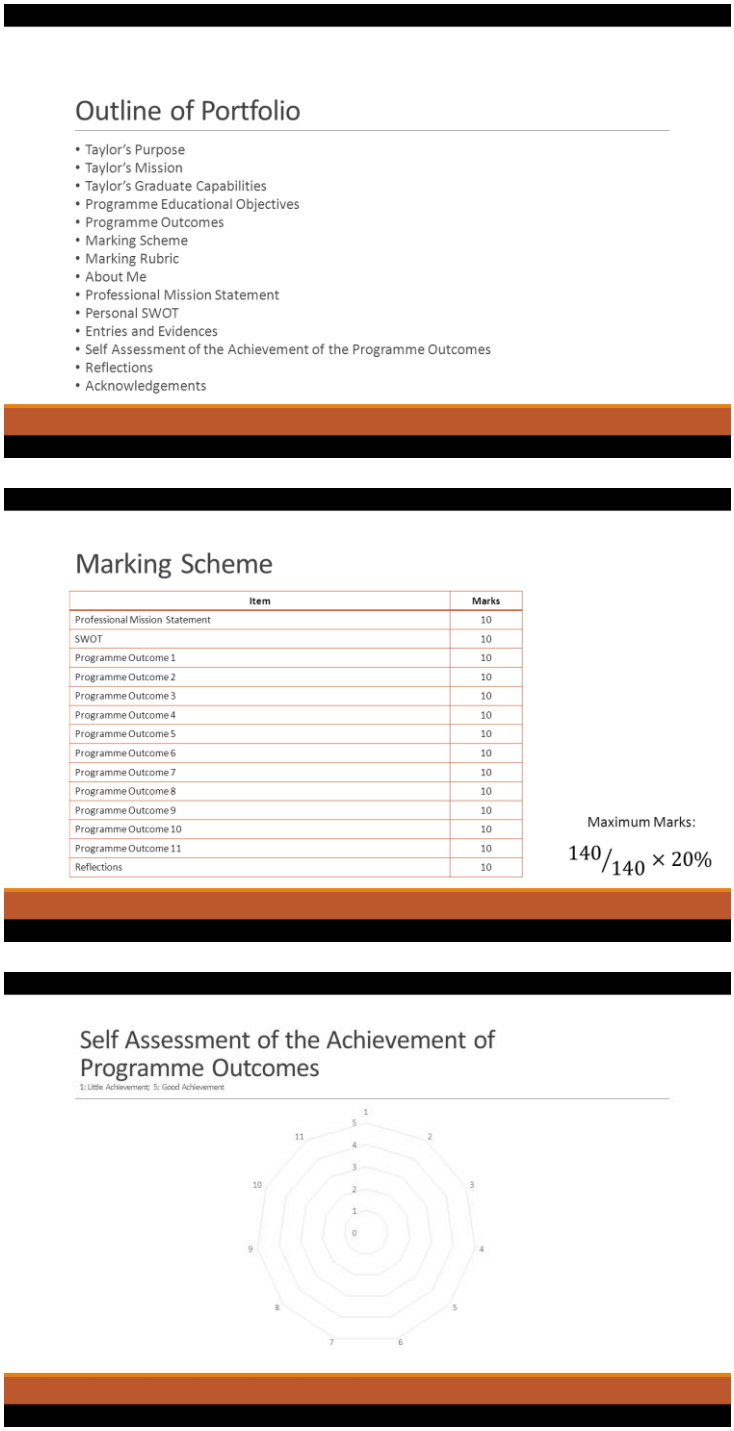

Fig. 4. PO Portfolio Screenshots.

Marking Rubric

Item	1-3 Marks	4-7 Marks	8-10 Marks
Mission Statement	A general statement that does not have a measurable outcome or a timeline. The Mission is well aligned with the Programme Educational Objectives.	A compelling mission that lacks either the measurable outcome or the timeline. The Mission is well aligned with the Programme Educational Objectives.	Well crafted and compelling mission that has a measurable outcome & a timeline. The Mission is well aligned with the Programme Educational Objectives.
SWOT	Identifies some strengths, weaknesses, opportunities and threats.	Identifies at least one key strength, weakness, opportunity and threat that can affect the achievement of the Mission.	Identifies three key strengths, weaknesses, opportunities and threats that can affect the achievement of the Mission.
PO1-11	The student needs to provide an accurate assessment of her/his achievement of the Programme Outcome.	To score 4-7 marks, the student needs to provide an accurate and critical assessment of her/his achievement of the Programme Outcome. This includes a clear and evidence-based account of the achievement of the Programme Outcome. A gap analysis of what is required to be done in order to achieve the Programme Outcome and the plans to close the gaps should be also present.	The highest mark does not necessary require the full achievement of the Programme Outcome, but rather requires the accurate assessment of the current state of the Programme Outcome achievement and a clear plan to close any gaps. To score 8-10 marks, the student needs to provide a very accurate and critical assessment of her/his achievement of the Programme Outcome. This includes a specific, clear and well written evidence-based account of the achievement of the Programme Outcome. A critical gap analysis of what is required to be done in order to achieve the Programme Outcome and the plans to close the gaps should be also present.
Reflections	A reflection on the gaps of the Programme Outcome achievement and how to close the gaps.	A SMART (Specific, Measurable, Achievable, Relevant, Timely) reflection on how to excel in achieving the Programme Outcomes.	A SMART (Specific, Measurable, Achievable, Relevant, Timely) reflection on how to excel in achieving the Programme Outcomes. This should be a critical reflection that identifies corrective actions, changes/improvements in attitudes and/or behaviours as well as resources allocation to ensure the achievement of the Programme Outcomes.

Fig. 5. PO Portfolio Marking Rubric.

3. Conclusions

The attainment of POs by graduating students from an engineering degree programme is of utmost importance. As the attainment of these POs relates the capability of the students upon graduation from the programme, similar urgency and importance must be placed in measuring the attainment. In current practice, this can be done in a variety of methods, namely by employing either a qualitative or quantitative process.

In the present investigation, the authors have described one of each. In the quantitative process, a comprehensive and exhaustive PO attainment software was created. The software would be used to extract the PO attainment score of each individual student enrolled in the programme and the PO attainment of a cohort of students.

For the qualitative process, a PO Portfolio was developed where the student could self-assess and interpret their own PO attainment by evaluating various evidences that they have collated and based on this, academic staff graded the portfolio based on a detailed rubric and hence provided the actual PO attainment score. The data would then be used to aid the schools Continual Quality Improvement (CQI) process during the annual programme review, where improvement action plans are drafted for implementation with the goal of enhancing student learning experience which ultimately leads to enhancing the PO attainment scores of the succeeding batch of students.

References

1. Engineering Accreditation Council. (2012). *Engineering Accreditation Manual* 2012. Available at http://www.eac.org.my/web/index.html.
2. Mohammad, A.W; and Zaharim, A. (2012). Programme outcomes assessment models in engineering faculties. *Asian Social Science*, 8(16), 115-121.
3. Rogers, G. (2003). Do grades make the grade for program assessment? Available at http://drjj.uitm.edu.my/DRJJ/MQAGGPAS- Apr2011/Gloria Rogers-CourseGradesForPragramGrades-Assessment%20Tips4.pdf
4. Thomas, C.; Britt, P.; Blackbourn, J.M.; Blackbourn, R.; Papason, B.; Tyler, J.L.; and Williams, F.K. (2005). Portfolio assessment: A guide for teachers and administrators. *National Forum of Educational Administration and Supervision Journal*, 23(4), 1-8.