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INTEGRATED CUMULATIVE GRADE POINT OUTCOMES AS A COMPLEMENT TO CGPA: A CASE STUDY FOR TAYLOR'S UNIVERSITY SCHOOL OF ENGINEERING

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Abstract

Due to the fast growing technological advancement and cultural diversity of engineering jobs, engineering education shifted its focus from the traditional input and teacher-centered into an output and student-centered framework through the Washington Accord (WA). The WA adopted Outcome-Based Education (OBE) to develop holistic and balanced graduates ready to embrace the complexity and multidisciplinary nature of engineering jobs in the workplace. To this date, many engineering schools are still struggling to find ways to explicitly measure and document the student's learning achievement upon graduation. Although OBE is being practiced by higher education institutions (HEI), the measure of graduate achievement, honors classification, and even the employment criteria are still very much dependent on cumulative grade point average (CGPA) system. Indeed CGPA is an indicator of academic performance and perhaps employability, but it is not specific enough to show what the graduate knows and be able to do upon graduation. The question is "How CGPA be made to convey the skill level achievement of the graduate?" An alternative measure needs to be developed that could show the holistic graduate capabilities to complement the CGPA. This paper presents a comprehensive assessment of the student's programme outcomes (PO) attainment using the integrated cumulative grade point outcomes (iCGPO) and integrated cumulative grade point average (iCGPA) derived from the student's PO scores from the culminating modules. PO scorecard was generated containing the iCGPO of the student's holistic learning achievements. PO Scorecard was indeed found to be complementing the academic transcript or the CGPA in particular. The End of Semester Assessment Tool (ESAT) was used in the assessment using macro-enabled routines to calculate the iCGPOs.

Keywords: Culminating modules, Integrated cumulative grade point outcomes, Outcome-based education, PO scorecard.

1. Introduction

The growth and trends in engineering education are triggered by the technological developments and the multidisciplinary job requirement of the 21st-century engineers. To meet this job complexity, the Higher Education Institutions (HEI) are obligated to prepare graduates to face tough engineering challenges in the job market. This endeavor is under the supervision and control of an International Engineering Alliance (IEA), a multilateral agreement, to establish and enforce among its members the internationally benchmarked standards for engineering education [1]. One of its agreement is the WA signed in 1989 which emphasize the importance of graduate attributes in developing quality graduates to face the 21st-century engineering challenges [2, 3]. The WA's mandate is to ensure equivalence among accredited programs of signatory member countries where the graduate engineer has the educational qualification for licensure, registration, and practice in another signatory member country [4]. Under this accord, HEIs are expected to produce graduates with diverse skills among which are to be lifelong learners, critical thinkers and effective communicators with good ethical standards and professionalism, ingenuity and creativity, business and management skills, leadership skills, and dynamic and resilient [5, 6]. Almost three decades since the implementation of OBE, many employers still find it difficult to get the right candidate for a specific job.

Moritz [7] stated in the Pricewaterhouse Cooper's 20th Chief Operating Office (CEO) global survey 2017, that "the hardest skills to find are those that cannot be performed by machines". In his report, 1,379 CEOs from 79 countries agreed that the five important skills are problem-solving 61%, adaptability 61%, leadership 75%, creativity, and innovation 77%, and emotional intelligence 64%. ManpowerGroup [8] reported in the 2016-2017, that global employers talent shortages were 35% in 2013, 36% in 2014 and 2015, and increased to 40% in 2016. In the 2015 job outlook report, JobStreet.Com [9] showed that up to 69% of the employers had difficulty in getting candidates with the right skills and 29% were unable to find candidates that match the job criteria.

The Aspiring Minds [10] of India in its 2014 Employability Report stated that only 7.47% of engineering graduates are employable. Its 2015 report posted up to 80% of engineers continue to be unemployable. All these reports found out that one of the common reasons for this difficulty is that candidates lack hard skills and soft skills particularly communication skills. In this respect, Jaschik [11] believes that students are not well prepared to bridge the skills gap between what the industry requires and what the HEI provides. Grade inflation is a common practice in many HEIs due to many diverse factors. Grade inflation misleads students into believing they are better prepared for the world of work than they really are. A study on this issue reveals that grade inflation is rampant in American education where 42% of four-year college grades are A's, and 77% are either A's or B's and A's are now three times more common than they were in the 1960s [11-13].

Roth [14] found out that the grades awarded in the earlier decade of the 21st century are a better predictor of job performance than those grades awarded in the later decades. Grade inflation is embedded in the CGPA which is a commonly used measure of academic performance, honors classification and even the employers' common metric for job placement. While CGPA is a good indicator of academic performance, it does not show the level of skills achievement and hence not

comparable [15]. Lazlo Bock, a Senior Vice President of Google said CGPA is "worthless" and "don't predict anything" and CGPA is not everything [16] since employers are looking at skills, qualities, and experiences that CGPA doesn't capture. With the adoption of OBE in engineering education, assessment of "what the student should know and be able to do" upon graduation is the main focus of the teaching and learning pedagogies [17]. Assessment drives learning [18] and should show the extent to which the student achieved the needed skills.

In the aforementioned cases and issues on CGPA and its inability to show the skill level achieved by graduates, it is imperative that an alternative measure to complement CGPA should be in place. This paper presents a PO Scorecard as a new metric to show the graduate's performance based on his achievement of the 12 POs. This PO scorecard can be attached to the transcript of records to provide an objective evaluation of the graduate attributes. It has been established that with an explicit assessment of the POs, the student's CGPA and PO attainment are highly correlated [19]. In this assessment, this paper seeks to answer the following research questions:

- How should the CGPA be made to convey the skill level achievement of the graduate?
- Does PO Scorecard complement CGPA?

These two research questions were the focus of this paper and were used to develop the research methodology provided in Section 2.

2. Methodology

Quantitative research was used in this study where the Taylor's Mechanical Engineering programme was used to assess the iCGPO scores of each student. The iCGPO calculation was carried using ESAT out similar to the CGPA calculation. Fig. 1 shows the iCGPO assessment methodology.

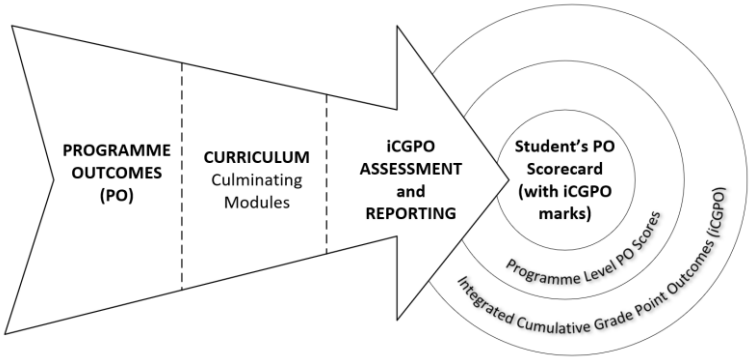

Fig. 1. iCGPO assessment methodology.

As indicated in Fig. 1, assessment of student's PO scorecard details the attributes to be assessed, the culminating modules of the curriculum, and the iCGPO assessment method and reporting. The November 2016 graduate cohort consisting of 25 students was used in this study. Due to the confidentiality of the students' record, a permission from the school management was sought to use the official transcript of records the students.

2.1. Programme outcomes (PO)

The 12 POs of the programme describing the graduate attribute that each student should achieve upon graduation was the focus of assessment and given as follows [20]:

1. **Engineering Knowledge**. Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems;
2. **Problem Analysis**. Identify, formulate, research literature and analyze 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 modeling, 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 to societal and environmental contexts and demonstrate knowledge of and the 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**. Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings;
11. **Life Long Learning**. Recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change; and
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 of a team, to manage projects and in multidisciplinary environments.

For each student, the aforementioned POs were assessed based on the approved culminating modules of the programme.

2.2. Culminating modules

The culminating modules of the programme curriculum were used in this assessment. These are the modules that require pre-requisites and believed to be where students are expected to demonstrate their learning skills. The students best perform if they are *introduced (I)* to the PO and given more time and opportunities to *reinforce (R)* their learning skills before being *assessed (A)* [21]. In a number of conferences and OBE workshops attended by the authors, OBE experts emphasized the use of culminating and other significant modules in PO assessment. This is supported by Killen [22] who stressed that assessment should reflect the knowledge and skills that are most important for students to learn. Similarly, the Engineering Accreditation Council (EAC) [20] manual listed the prescribed minimum significant modules that an OBE curriculum should offer. The number of culminating modules is 25 or 56.8% of the entire curriculum. Table 1 shows the mechanical engineering programme curriculum where each module is mapped explicitly to one or more POs using the I/R/A concept.

Table 1. Curriculum with Introduced/Reinforced/Assessed PO Mapping

	Programme Outcomes (PO)											
Modules Code	1	2	3	4	5	6	7	8	9	10	11	12
Year 1, Sem 1												
MTH60103	I	I										
ENG60103	I	I		I								
ENG60203	I	I		I								
PRJ60103	I	I	I									
Year 1, Sem 2												
MTH60203	I	I										
ENG60403	I	R		I								
ENG60303	I	R		R								
PRJ60203			A			A	A					
Year 2, Sem 1												
MTH60303	R	R										
ENG60503	A	A		A								
ENG60603	A	A										
PRJ60303		A	A				A			A		
ENG60104	A	A			A							
Year 2, Sem 2												
MTH60403	A	A										
ENG60703							A			A		A
PRJ60403	R	R	R									
MEC60203	A	A		A								
MEC60103	R	R		R								
Year 3, Sem 1												
ENG60903		R										
ENG61203	R				R							
PRJ60503			A				A		A	A	A	A
MEC60303	A	A										
ENG61103	A	A			A							
Year 3, Sem 2												
ENG61003	A	A		A								
BUS60403			A			A				A		A
PRJ60603			A	A	A		A	A	A	A	A	A
MEC60503	A	A		A	A							
MEC60803	A	A										

It can be observed in Table 1 that the modules are explicitly mapped to the POs where each module is mapped as either ***I**ntroduced*, ***R**einforced* or ***A**ssessed*. The markings of "I" and "R" are the introduction and reinforcement (based on pre-

requisites and relevant modules) to acquire the learning skills towards the module to be assessed. Those with marked "A" are the modules (culminating) considered for assessment. Of the 25 culminating modules, 14 or 56% are year 3 and year 4 modules. Cognitive skills POs consist of PO1 to PO4 or about 45%, Psychomotor skills POs consist of PO3, PO5, PO9, and PO10 or about 28.2% and the rest are affective skills POs or about 26.8%. This is not surprising considering that Taylor's School of Engineering is heavily focused on project-based learning with 4 project modules in year 1 and year 2, 2 capstone modules in year 3, and 2 final year project modules. Looking at the snapshots of the assessed modules mapped to each PO showed that there is a good distribution of the mapping. OBE experts emphasized that each PO should have at least 2 opportunities to be assessed. The PO-LO matrix and the selection of culminating modules were endorsed by the programme and approved by the Board of Studies (BoS) of the school for implementation.

2.3. PO assessment and reporting

For each module, each assessment tasks were explicitly mapped to the LOs and POs, and each LO is explicitly mapped to the POs as shown in Tables 2(a) and (b) screenshots.

As shown in Table 2(a), each assessment task is given an explicit percent weight and was explicitly mapped to the LOs based on the taxonomy level of the mapped LOs. LOs are automatically normalized to 100.

As indicated in Table 2(b), explicit mapping means each assessment task was directly mapped to the POs where the percent emphasis on each PO was carried over from the weight given to the assessment tasks. Upon marks entry, each PO is calculated based on the accumulated PO score divided by the maximum target PO score. Key performance indicator (KPI) is considered achieved if the percent PO score is at least 60.

Table 2(a). Explicit mapping of assessment tasks to LO.

WHITE COLOURED CELLS ARE EDITABLE.		ASS.	ASSESSMENT TASKS - LEARNING OUTCO							
AT CODE	ASSESSMENT TASKS	WEIGHT	LO1	LO2	LO3	LO4	LO5	LO6	LO7	LO8
T1	Test 1	10.00%	40	60						
T2	Test 2	10.00%		40	20	40				
L	Lab	10.00%		100						
F	Final Q1	7.00%	10							
F	Final Q2	7.00%	10							
F	Final Q3	17.50%		25						
F	Final Q4	17.50%		25						
F	Final Q5	10.50%			15					
F	Final Q6	10.50%				15				

Table 2(b). Explicit mapping of PO to LO.

THIS SECTION CONSISTS OF PO-LO, AND CPA-LO MAPPING. THE SAID MAPPING ARE AUTOMATICALLY GENERATED BY THE SYSTEM BASED ON THE SELECTED MODULE. YOU NEED NOT DO ANYTHING IN THIS SECTION.			Engineering Knowledge	Problem Analysis	Design/Development of Solutions	Investigation	Modern Tool Usage	The Engineer and Society	Environment and Sustainability
CODE	LO STATEMENTS	I/R/A	PO1	PO2	PO3	PO4	PO5	PO6	PO7
LO1	Explain static pressure and hydrostatic forces in subm		T1,F						
LO2	Analyse fluid flow in engineering systems by applying			T1,L,F		T2,F			
LO3	Create dimensionless equations for engineering syste			T2,F					
LO4	Evaluate the flow in viscous media using energy balan		T2,F						
LO5									

At the programme level, a student PO database is set up to consolidate the modules PO scores for all students and for all culminating modules. PO assessment is carried out in a cumulative manner similar to CGPA system calculation resulting in what is termed as *cumulative grade point outcomes* (CGPO). The student CGPO is the cumulative total of each PO throughout the programme of study. This means that the module credits are made part of the calculation. The CGPO calculation is accomplished using an Excel macro-enabled End of Semester Assessment Tool (ESAT) developed for such purpose. Table 3 shows the screenshot of the CGPO table and involved a more complex calculation process as follows:

Table 3. Calculation of iCGPO and iCGPA scores using ESAT.

STUDENT ID	NAME OF STUDENT										
INTEGRATED COMULATIVE GRADE POINT OUTCOMES (iCGPO) SCORES											
SEM.	iCGPO1	iCGPO2	iCGPO3	iCGPO4	iCGPO5	iCGPO6	iCGPO7	iCGPO8	iCGPO9	iCGPO10	TOTAL
	SEM 1	SEM 2	SEM 3	SEM 4	SEM 5	SEM 6	SEM 7	SEM 8	SEM 9	SEM 10	iCGPO
CGPO1											
CGPO2											
CGPO3											
CGPO4											
CGPO5											
CGPO6											
CGPO7											
CGPO8											
CGPO9											
CGPO10											
CGPO11											
CGPO12											
iCGPO											
iCGPA											
GPA											
CGPA											

- Each semester iCGPO is calculated using the weighted cumulative PO scores from semester 1 up to the last semester.
  - ✓ The percent share of each PO in the 12 PO set is calculated using Eq. (2)

$$Sum\ PO\ Score = \sum_{n=1}^{12} PO_n\ Score \quad (1)$$

$$\%Share\ PO_n Score = \frac{PO_n\ Score}{Sum\ PO\ Score} x100\% \quad (2)$$

where n = PO number

  - ✓ The semester iCGPO is calculated based on Eq. (5)

$$Credits_n^s = \sum_{q=1}^{s} \sum_{m=1}^{p} Credits_m x\%PO_n Score \quad (3)$$

$$Weighted\ PO_n^s = \sum_{q=1}^{s} \sum_{m=1}^{p} \frac{PO\ Score_n^m}{PO\ Max_n^m} x\ \%Share\ PO_n Score\ x\ Credits_m \quad (4)$$

- The iCGPO for each PO for all culminating modules is given by Eq. (5).

$$iCGPO_n^s = \frac{Weighted\ PO_n^s}{Credits_n^s} \quad (5)$$

where n = PO number
s = current semester
p = semester modules

- The 12 iCGPOs were accumulated into a single semester iCGPO using Eq. (6) and the corresponding iCGPA is given by Eq. (8).

$$iCGPO_t^s = \frac{\sum_{n=1}^{12} Weighted\ PO_n^s}{\sum_{n=1}^{12} Credits_n^s} x100\% \quad (6)$$

where n = PO number
s = semester number
t = total

The iCGPA is calculated using weighted grades of the respective POs and given by Eq. (8)

$$Weighted\ POGrade_n^s = \sum_{q=1}^{s}\sum_{m=1}^{p} POGrade_n^m x\ \%Share\ PO_n Score\ x\ Credits_m \quad (7)$$

$$iCGPA_t^s = \frac{\sum_{n=1}^{12} Weighted\ POGrade_n^s}{\sum_{n=1}^{12} Credits_n^s} x100\% \quad (8)$$

The iCGPA and the official CGPA will be subjected to a statistical test (Analysis of Variance (ANOVA)) determine if there exists a significant correlation between them. This relationship was also studied by Gamboa and Namasivayam (2016) using the previous cohorts and found that they are highly correlated (p = 0.6905 at 5% level). From the generated results, a PO scorecard will be generated to show the student's level of achievement of the POs, the 12 iCGPOs in a web diagram form. The iCGPO is considered satisfactory if the student achieved at least 60 (KPI). If iCGPA is found to be highly correlated to CGPA then PO Scorecard can be attached to the student's transcript of record which can be used for employment and other purposes.

3. Results and Discussion

As stated in the methodology, the PO database was set up and PO scores of all students of the programme from semester 1 to the last semester were organized and set up for PO assessment. For each student, the iCGPO and iCGPA were generated by implementing Table 3 as detailed in Section 2. Table 4 shows the screenshot of iCGPO and iCGPA calculation results for November 2016 graduates. It also includes the official CGPA record of the graduates. An ANOVA test conducted between iCGPA and CGPA was carried out as shown in Table 5.

In Table 4, the names of the graduates were not revealed to protect their identity. The single iCGPO and iCGPA were results of the integrated cumulative calculation (based on module credits) of the 12 iCGPOs derived from the PO scores of the culminating modules. It can be noticed from Table 4 that CGPA and iCGPA are practically similar.

Based on the statistics result from Table 5, the p-value (0.851) > significance level (0.05). This means that there is a significant correlation between CGPA and iCGPA. The student's iCGPO and iCGPA results for a good student (CGPA = 3.69) is shown in Table 6.

Also, semester by semester comparison of the iCGPA and the official CGPA record is presented. Later in this paper, a statistical analysis will be conducted to verify their correlation. The corresponding PO scorecard is shown in Fig. 2.

Table 4. iCGPO and iCGPA calculation result for November 2016 graduates.

	NOVEMBER 2016 GRADUATES		Official		Equivalent
	STUD. ID	NAME OF STUDENTS	CGPA	iCGPA	iCGPO
1			2.66	2.47	60
2			2.76	2.63	62
3			2.92	3.01	68
4			2.69	2.71	63
5			2.75	2.67	63
6			2.61	2.42	60
7			3.48	3.32	73
8			2.81	2.93	66
9			3.33	3.19	70
10			3.50	3.39	75
11			2.90	2.62	63
12			2.81	2.73	64
13			2.99	2.76	64
14			2.89	2.69	64
15			3.31	3.28	72
16			3.42	3.38	74
17			2.88	2.83	65
18			3.04	2.98	68
19			2.49	2.21	57
20			3.07	3.10	69
21			3.43	3.25	72
22			2.98	2.89	65
23			3.69	3.49	77
24			2.80	2.78	64
25			2.81	2.78	64

Table 5. ANOVA test between CGPA and iCGPA.

CGPA Vs. iCGPA (November 2016 Graduates)
Summary statistics:

Variable	Observations	Obs. with missing data	Obs. without missing data	Minimum	Maximum	Mean	Std. deviation
Official CGPA	25	0	25	2.490	3.690	3.001	0.320
iCGPA	25	0	25	2.210	3.490	2.900	0.333

Fisher's F-test / Two-tailed test:

95% confidence interval on the ratio of variances:
] 0.408, 2.100 [

Ratio	0.925
F (Observed value)	0.925
F (Critical value)	2.269
DF1	24
DF2	24
p-value (Two-tailed)	0.851
alpha	0.05

Test interpretation:
H0: The ratio between the variances is equal to 1.
Ha: The ratio between the variances is different from 1.

As the computed p-value is greater than the significance level alpha=0.05, one cannot reject the null hypothesis H0.

The risk to reject the null hypothesis H0 while it is true is 85.11%.

Table 6. iCGPO calculation for good student.

03											
INTEGRATED COMULATIVE GRADE POINT OUTCOMES (iCGPO) SCORES											
SEM.	iCGPO1	iCGPO2	iCGPO3	iCGPO4	iCGPO5	iCGPO6	iCGPO7	iCGPO8	iCGPO9	iCGPO10	TOTAL
	Aug 12	Mar 13	Aug 13	Mar 14	Aug 14	Mar 15	Aug 15	Mar 16	SEM 9	SEM 10	iCGPO
CGPO1	88	88	83	83	82	79	79	79			79
CGPO2	87	87	83	83	77	76	76	76			76
CGPO3	88	84	85	85	83	83	82	81			81
CGPO4	92	92	86	86	86	81	81	80			80
CGPO5			80	80	74	74	73	73			73
CGPO6		80	80	79	79	78	78	78			78
CGPO7		78	82	82	78	77	77	79			79
CGPO8								79			79
CGPO9					80	80	79	78			78
CGPO10			89	83	83	76	76	76			76
CGPO11					63	63	66	74			74
CGPO12				82	82	82	82	81			81
iCGPO	88	85	83	83	80	79	78	78			78
iCGPA	4.00	3.92	3.91	3.91	3.72	3.68	3.66	3.66			3.66
GPA	3.92	3.92	3.94	3.80	3.33	3.80	3.33	3.73			
CGPA	3.92	3.92	3.93	3.89	3.77	3.74	3.68	3.69			3.69

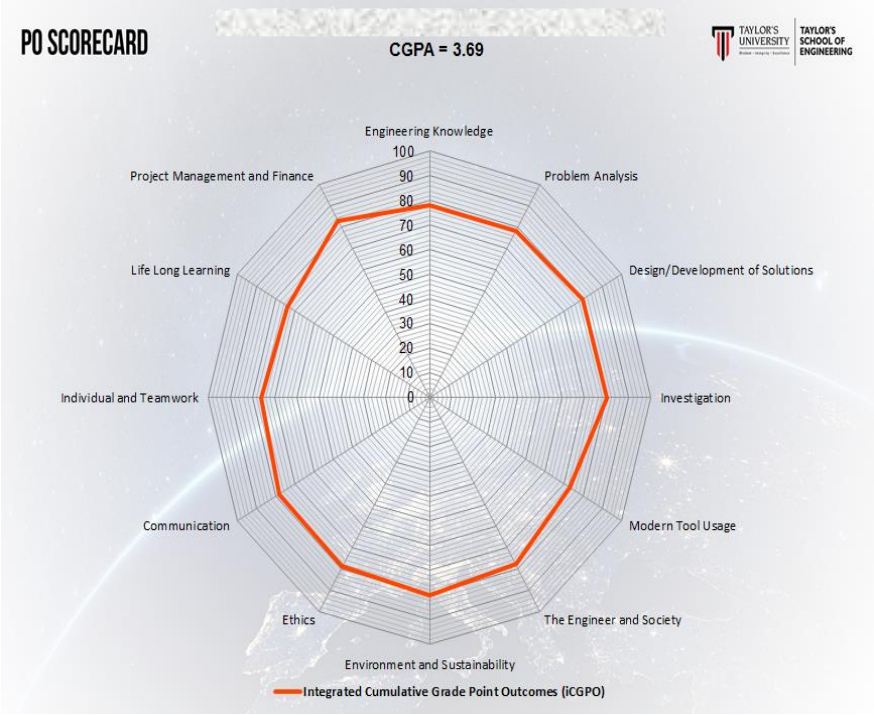

Fig. 2. PO scorecard for a good student.

It can be observed in Fig. 2 how well the student achieved the intended learning outcomes (iCGPOs). There are consistency and awareness in his achievements, a typical example of the holistic development of the individual skills. Table 7 shows the result for an average student with his PO Scorecard shown in Fig. 3.

Table 7. iCGPO calculation for an average student.

INTEGRATED COMULATIVE GRADE POINT OUTCOMES (iCGPO) SCORES											
SEM.	iCGPO1	iCGPO2	iCGPO3	iCGPO4	iCGPO5	iCGPO6	iCGPO7	iCGPO8	iCGPO9	iCGPO10	TOTAL
	Aug 12	Mar 13	Aug 13	Mar 14	Aug 14	Mar 15	Aug 15	Mar 16	SEM 9	SEM 10	iCGPO
CGPO1	70	70	68	65	64	62	62	62			62
CGPO2	72	72	71	71	65	64	62	63			63
CGPO3	70	59	62	62	64	63	63	64			64
CGPO4	75	75	75	61	61	61	61	61			61
CGPO5			66	66	61	61	61	61			61
CGPO6		47	47	56	56	62	62	58			58
CGPO7		46	58	58	58	64	64	67			67
CGPO8								55			55
CGPO9					70	70	68	67			67
CGPO10			73	69	69	65	65	65			65
CGPO11					57	57	60	64			64
CGPO12				66	67	73	73	73			73
iCGPO	71	63	66	65	64	64	63	63			63
iCGPA	3.17	2.59	2.88	2.85	2.76	2.75	2.73	2.74			2.74
GPA	3.25	1.92	2.79	2.50	2.33	2.67	2.67	2.67			
CGPA	3.25	2.59	2.88	2.76	2.67	2.67	2.67	2.69			2.69

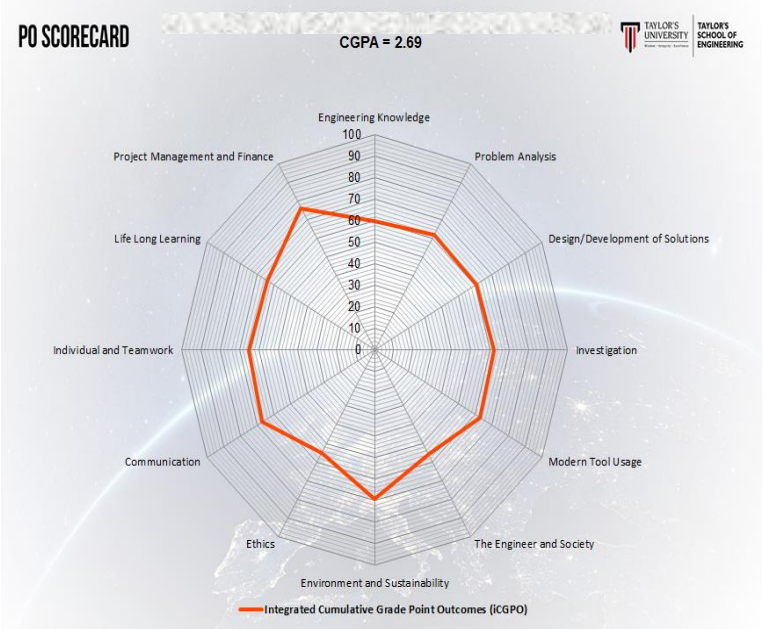

Fig. 3. PO scorecard for an average student.

It can be observed in Fig. 3 that there are ups and downs in the achievement of the iCGPOs basically typical to an average student. Similarly, the result of a below average student is shown in Table 8 and his PO Scorecard is shown in Fig. 4.

Table 8. iCGPO calculation for below average student.

INTEGRATED COMULATIVE GRADE POINT OUTCOMES (iCGPO) SCORES											
SEM.	iCGPO1	iCGPO2	iCGPO3	iCGPO4	iCGPO5	iCGPO6	iCGPO7	iCGPO8	iCGPO9	iCGPO10	TOTAL
	Aug 12	Mar 13	Aug 13	Mar 14	Aug 14	Mar 15	Aug 15	Mar 16	SEM 9	SEM 10	iCGPO
CGPO1	33	33	50	50	51	54	54	53			53
CGPO2	43	43	60	60	54	54	54	52			52
CGPO3	33	49	53	53	59	61	61	61			61
CGPO4	67	67	58	58	58	67	67	70			70
CGPO5			64	64	58	58	58	60			60
CGPO6		70	70	68	68	72	71	67			67
CGPO7		68	70	70	70	76	75	69			69
CGPO8								70			70
CGPO9					79	79	65	63			63
CGPO10			74	70	70	63	63	63			63
CGPO11					67	67	61	60			60
CGPO12				75	76	74	74	74			74
iCGPO	37	47	57	59	58	59	60	60			60
iCGPA	1.20	1.83	2.36	2.49	2.36	2.42	2.43	2.46			2.46
GPA	2.40	3.20	2.71	2.67	2.20	2.80	2.28	2.60			
CGPA	2.40	2.80	2.77	2.74	2.63	2.66	2.67	2.66			2.66

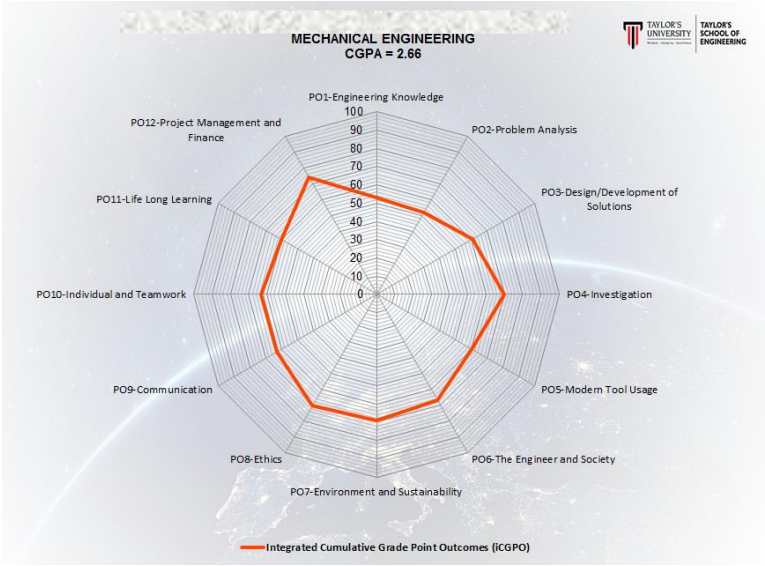

Fig. 4. PO scorecard for below average student.

The three sample results from Figs. 2 to 4 showed a consistent relationship between CGPA and the iCGPO. It can be noticed in Fig. 3 that there are signs of inconsistencies in the performance of an average student as shown by the spikes in his achievement. This is more evident in below average student shown in Fig. 4. It can also be seen how a below average student struggles to finish his degree. He is quite weak on knowledge, design and development skills, and his personal and preparedness.

4. Conclusions

The integrated cumulative assessment of the 12 POs in the programme level using the November 2016 graduates cohort of the Mechanical Engineering programme was done through ESAT using macro-enabled routines to accomplish the iCGPO

table and supported by established equations. This resulted in the development of the student's PO scorecard detailing how well the student achieved the graduate attributes. The following conclusion is hereby drawn:

- The CGPA was made to convey the acquired skill level of the graduate through the PO scorecard.
- The iCGPO is highly correlated to CGPA which means that the PO scorecard can be used as a supplement to the academic transcript or complement to CGPA. The PO scorecard can also be used as a new metric by the employers for their initial recruitment process. The PO scorecard to monitor the student's progress in a semester basis and could be a motivating factor for him/here to maximize the learning potential.

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