

## Assessment Method for Course Outcome and Program Outcome In Outcome Based Education (OBE)

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**Abstract**—Outcome Based Education (OBE) has become the standard of practice in Higher Education Institutions especially those that offer programs in engineering. This paper introduces a method to measure students' performance in respect to OBE concept. The flow of measurement is taken from students' progress marks and also final exam. The marks are then converted whether they meet the course outcome set by instructor. After getting the course outcome score, contribution of each course to program outcome can be measured progressively until students complete their 4 year program. In getting the score Program Outcome, the instructor would plan earlier on the assessment question specification to program outcome. The method is found to be very practical to be implemented for any instructor to measure the course outcome and program outcome. In addition, it would contribute to the continuous quality improvement process as specified by Washington Accord as well as Engineering Accreditation Council, Malaysia.

**Keywords:** Program Outcome, Course Outcome, OBE.

### I. INTRODUCTION

Assessment in Outcome Based Education can be done in many different ways by respective institution to reflect the process of Continuous Quality Improvement (CQI).

Since the concept of OBE was relatively new, some may find that the assessment for OBE is rather cumbersome and will take a lot of energy in keeping track of students for every course at any given time. And this has to be done continuously for as long as the program needed to be accredited by the respective Engineering Accreditation Council approved by Washington Accord. The guide by the accreditation is rather insufficient for any program owner to

be confident of their assessment documentation. However, a method is devised and used in practice by Faculty of Mechanical Engineering to measure the achievement of course outcome in relation to program outcome which later should meet the program objectives. The achievement of program outcome needed to be measured so that continuous improvement can be done to upgrade the quality of engineering graduates. There are two level of assessment measurement; one is at the course level and another one is at the cohort level. For every course, the course attainment is recorded and later become input to cohort level assessment which takes in to account all courses taken by each cohort at any given semester. To ensure that the attainment is kept into record, few forms needed to be produced by course instructor and this will become the base for the next time improvement to be done. The form will include the marks distribution and table for course outcome attainment as well as table for program outcome attainment.

### II. LITERATURE REVIEW

According to (Javed et al 2009), an accredited engineering program is judged as providing satisfactory preparation of graduates, to initially enter the profession as registered engineers and then develop their skills subsequently to the level of professional engineers. The accreditation process is designed to publicly assure the competence of graduates, independent of the certification and credentials provided by the institutions of engineering education.

To achieve such accreditation, the institution must follow specified criteria by one's country engineering accreditation council. As one should know "Accreditation involves and evaluation and assessment of undergraduate and postgraduate programs offered by universities and other educational providers, through a well-defined, peer review process in which endorsements based on broadly designated parameters and criteria are rendered" (Javed et al 2009). As Program Outcomes come into action, one must devised a way to assess and measure them. An analogous and equally important distinction is that between competence and performance articulated by Chomsky (1965).

"Program Outcomes are statements that describe what students are expected to know and able to perform or attain by the time of graduation. These relate to the skills, knowledge, and behavior that students acquire through the programme." (EAC Manual 2007). From EAC Manual, students of an engineering programme are expected to attain as follows:

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- (i) ability to acquire and apply knowledge of science and engineering fundamentals;
- (ii) acquired in-depth technical competence in a specific engineering discipline;
- (iii) ability to undertake problem identification, formulation and solution;
- (iv) ability to utilise systems approach to design and evaluate operational performance;
- (v) understanding of the principles of design for sustainable development;
- (vi) understanding of professional and ethical responsibilities and commitment to them;
- (vii) ability to communicate effectively, not only with engineers but also with the community at large;
- (viii) ability to function effectively as an individual and in a group with the capacity to be a leader or manager ;
- (ix) understanding of the social, cultural, global and environmental responsibilities of a professional engineer; and
- (x) recognising the need to undertake life-long learning, and possessing/acquiring the capacity to do so.

(EAC Manual 2007).

D. Andrich summarized that in OBE, outcomes are focused rather than inputs. By that, it does not mean inputs are not important; on the other hand inputs are a means to achieving the outcomes. It was suggested that different students might reach the outcomes by different routes and with different resources (D. Andrich, 2002).

### III. METHODOLOGY

To measure the attainment of Course Outcome and Program Outcome, EAC has given guide that the Course Outcome should be mapped to Program Outcome. The method of mapping is left to each program owner as long as it can show that the achievement of Course Outcome will contribute to the achievement of Program Outcome.

For every course, there should be a number of outcomes to be achieved at the end of course. This outcome is usually a combination of main course content and may cover more than one topic. To ease the attainment checking, it may be wise to combine several chapter to make up for one course outcome. This chapter combination has to have some link so that it can be said that the course outcome cover the combined content. For rule of thumb, a 3 credit course for 15 weeks should have around 5 course outcomes. The mapping of course outcome is made to link to program outcome. ABET has proposed ten program outcome for an engineering program. Program owner may add up the program outcome to complement with own requirement. In table below, a table is shown which link the course outcome to program outcome in a way that the linking has a weightage from 1 to 3. The interpretation of the weightage value is left to program owner to decide on. But the essence is that the linking should have some differentiation which one can identify.

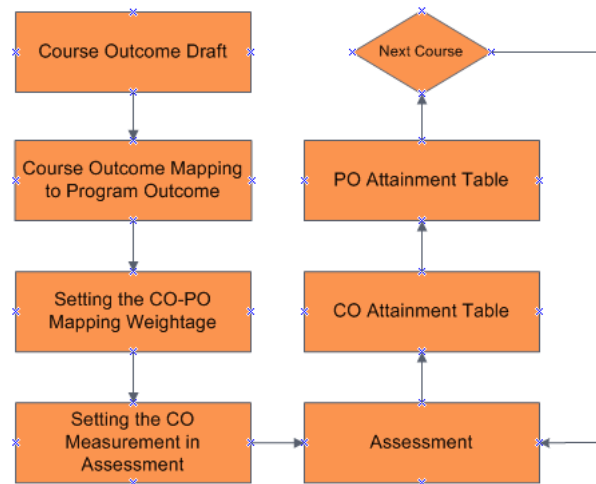


Figure 1

The flowchart above (Figure 1) outlines the steps before Program Outcome attainment can be measured and calculated. Before any assessment is done, it is critical to set how one want to assess the Course Outcome. This has to be specific up to the number of question in examination as well as any related assignment and project. The level of attainment also need to be outlined and agreed among program owner members so that everyone will have the same standard to be referred to.

### IV. RESULTS AND DISCUSSIONS

#### 1. Course Outcome Mapping to Program Outcome

Course Outcomes from Fluid Mechanics are taken to be analyzed. There are five associated course outcomes as decided by the instructor. They are as follows:

- CO1: Solve fluid statics based problems.
- CO2: Solve fluid in motion problems.
- CO3: Solve fluid friction in pipes problems.
- CO4: Solve fluid flow measurement problems.
- CO5: Apply the concept of dimensional analysis

All of this Course Outcomes shall have linkage to Program Outcomes in such a way that the strongest relation has the value of 3 whereas the least relation is rated 1. For this case, the standard Program Outcomes are taken from EAC Manual which are 10 in numbers. The relation is put into table as shown in table 1.

Table 1

CO \ PO	1	2	3	4	5	6	7	8	9	10
CO1	2				3		1			
CO2	2				3		1			
CO3	2				3		2			
CO4	2				3		1			
CO5	2				3		1			

Next, the assessment which will measure the Course Outcomes shall be decided. For instance, CO1 and CO2 is to be assessed in Test 1, while CO3 and CO4 to be assessed in Test 2. Assignment and Final Exam shall assess all of the COs. If that is the case, then a second table can be drafted to include the COs and where it would be assessed. This is indicated in Table 2. Ideally, the assessment should go to the depth of the question number and not just generalized as assignment and exam.

**Table 2**

Course Outcome	Assessment	% Total	Result
CO1	Test 1, Final Exam, Assignment	a	Y
CO2	Test 1, Final Exam, Assignment	b	N
CO3	Test 2, Final Exam, Assignment	c	Y
CO4	Test 2, Final Exam, Assignment	d	N
CO5	Final Exam, Assignment	e	N

## 2. Course Outcome Attainment

For the detail assessment division, Table 3 indicates the subdivision of each question or assignment that relate to the specific COs. As shown in the table, for Test 1 (T1) there are 4 number of questions; Q1 and Q2 is to assess on CO1 while for Q3 and Q4, they are for CO2 assessment. Similar cases for Test 2 (T2) applied, two of them are designated to measure CO3 and another two for assessing CO4.

In addition, all CO1 to CO5 are measured also using assignments (Asgn) and Final Exam (FE). The column '% Total' contains 'a', 'b', 'c', 'd', 'e' which is just the sum of each row normalized to 100. The column 'result' is to indicate whether each CO is achieved using value from column '%Total'. The last column only represents 'Yes' or 'No'.

**Table 3**

Course Outcome	Assessment				% Total	Result
	T1	T2	Asgn	FE		
CO1	Q1,Q2		A1, A2	Q1	a	Y
CO2	Q3,Q4		A3, A4	Q2	b	N
CO3		Q1,Q2	A5, A6	Q3	c	Y
CO4		Q3,Q4	A7, A8	Q4	d	N
CO5			A9, A10	Q5	e	N

To measure the attainment for each CO, it is imperative to decide on the appropriate value of mark that will indicate that the CO is achieved. For example, an average number of 50 out of 100 may be chosen as the minimum level of mark needed to be obtained by students. If that so, from table 1 then,

If for each student,

$$(Q1 \text{ from Test 1}) + (Q2 \text{ from Test 1}) + (A1 + A2) + (Q1 \text{ from Final Exam}) \geq 50\%, \text{ then CO1 is achieved.}$$

**Table 4**

Student	CO1					Total (%)	CO Met (Y/N)
	Q1 (T1)	Q2 (T2)	Asgn 1	Asgn 2	Q1 (F.E)		
1. Ali	2	1	1	2	2	8	Y
2. Abu	0.5	0.5	1.5	2	2	6.5	N
3. Lai	1.3	1.5	1	1	5	9.8	Y
4. Raja	1.8	2	2	1	3	9.8	Y

To best visualize the arithmetic, it is easier to take each mark as the portion of mark towards final course score. Q1 from Test 1 may just contribute 3% towards the overall final score. Q2 from Test 1 might just contribute 2% and Assignment 1 and Assignment 2 give another 4% and lastly Q1 of Final Exam constitutes 5%. So altogether the total of mark that justifies CO1 is only 14% from final overall score. To be able to say that CO1 is achieved for any student, s/he need to get at least 7% so that it counts as 50% of total possible score for CO1. The last column of Table 4 is summarized in Table 5.

Afterward, one can draft a table to list out all students' CO achievement and hence can identify how many percent of total students who actually achieve any CO. This is shown in Table 5.

**Table 5**

Students	CO1	CO2	CO3	CO4	CO5
1. Ali	Y	Y	Y	Y	N
2. Abu	Y	N	Y	N	N
3. Lai	Y	N	Y	Y	N
4. Raja	N	N	Y	Y	Y
% Students achieve CO	3/4*	1/4*	4/4*	3/4*	1/4*
	100	100	100	100	100
CO Result	Y	N	Y	Y	N

The step covered just explains the CO attainment for every student in that course. To see a bigger picture, one need to examine how many of his/her students who get the minimum CO attainment of 50%. Therefore one can calculate the percentage of students who get just that and whether it meet the CO target; this is shown in last two rows of Table 5.

Say total students = W

If one set 50% of students need to achieve 50% marks for each CO, then at least W/2 number of students need to get 50% CO Score so that the CO can be said to be achieved. For case in Table 4, only CO1, CO3, and CO4 are achieved.

### 3. Program Outcome Attainment.

Next, the achievement of the COs needs to be linked to the achievement of the POs or Program Outcome. To do this, value from Table 1 is used to calculate the score for Program Outcome. Table 4 shows the linkage from COs to the POs. 'CO Result' column shown below is just an example of CO attainment. For this case, CO1, CO3, and CO4 are set as achieved whereas CO2 and CO5 are set as not achieved.

**Table 6**

CO	PO	1	2	3	4	5	6	7	8	9	10
	CO Result										
CO1	Y	2				3		1			
CO2	N	2				3		1			
CO3	Y	2				3		2			
CO4	Y	2				3		1			
CO5	N	2				3		1			
PO Attainment		x				y		z			

From Table 4, for each of the CO that is achieved (Y), the weightage in the matrix is calculated towards the value of PO Attainment. From example in Table 4, CO1, CO3, and CO4 is met, therefore the weightage is to be calculated from the overall sum of weightage for PO1. The bolded weightage represents the CO which is achieved.

In this case for PO1,

$$\begin{aligned} \text{PO Attainment} &= (2+2+2) / \text{Sum PO1\_Weightage} * 100 \\ &= 6 / 10 * 100 \\ &x = 60 \% \end{aligned}$$

Multiplying by 100 is just to get the percentage of PO Attainment.

For PO5,

$$\begin{aligned} \text{PO Attainment} &= (3+3+3) / \text{Sum PO1\_Weightage} * 100 \\ &= 9 / 15 * 100 \\ &y = 60 \% \end{aligned}$$

For PO7,

$$\begin{aligned} \text{PO Attainment} &= (1+2+1) / \text{Sum PO1\_Weightage} * 100 \\ &= 4 / 6 * 100 \\ &z = 66.7 \% \end{aligned}$$

The calculated PO Attainment is just the partial contribution of one course towards the Program Outcomes. In any case, all of courses need to be evaluated the same way progressively. After getting the PO Attainment for all of courses in the same semester, one can use statistical method to determine the overall PO Attainment contribution for one semester. An average value may be used to get the distribution of the PO Attainment for all courses in one semester. Later towards the completion of 4-year program, the program owner could get the overall PO Attainment for all semesters. Only this final PO Attainment (all semesters) can be said as the Program Outcomes measurement for any cohort or entry.

### V. CONCLUSION

The method of finding the Course Outcome and Program Outcome attainment is introduced. The biggest difficulty faced by program owner often related to how they could link Course Outcome attainment and Program Outcome attainment. While measuring Course Outcome can be very easy but linking it to the attainment of Program Outcome is another matter. The logic behind this method introduced is that students will only achieve Program Outcome if only they achieve the associated Course Outcome. Thing to be adapted by each program owner is how they would link the Course Outcome to the Program Outcome. It is advisable to discuss thoroughly on the weightage criteria; the fact is it is not necessary to rate the link from 1 as the lowest emphasis and 3 as the highest emphasis. Emphasis or weightage can be modified to bring a new meaning to the mapping. The end cause is to identify how 'true' the Course Outcome relate to the Program Outcome. The option may be to produce rubric so that everybody has the same idea or guide on deciding the mapping emphasis. Another important step is to agree on what level or mark or score that will constitute achieving the Course Outcome and Program Outcome. In this paper, the set level is that 50% of students get 50% overall mark in order for program owner to be able to say Course Outcome is achieved. For each individual student, s/he needs to get a least 50% of marks associated with the Course Outcome to be said as achieving it. The said value can be any value depending on the students' ability, grading scheme and the Program Objectives.

By taking Outcome Based Education concept, one should at all time taking measurement of the cohort progress. Any intervention can be done to improve the Course Outcome attainment as well as the Program Outcome attainment before the cohort finishing the program. After each cohort has completed the program, the overall PO Attainment can be based as benchmark to the next cohort. In any case, the value or numbers from the PO Attainment is just a number and it may bring meaning to some standard or it may be meaningless. Depending to what measure has been done to keep track of the process and quality, Program Outcome measurement can ensure the students produced have been included in continuous quality improvement process and therefore by the very meaning of Outcome Based Education (OBE), engineering students should be getting better from time to time.

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