

Developing a Software Package for Outcome Based Education

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Abstract: In the present global scenario, competitiveness in the industry has increased tremendously and so has the expectations from the industry towards the upcoming skilled graduates. To cope up with rising industry standards and expectations, institutes across the world try different ways to improve the quality of technical education. Outcome Based Education (OBE), which propagates that an educational system must meet a set number of outcomes. It has been well accepted globally to improve the academic standards. The National Board of Accreditation (NBA), India, has laid down a set of guidelines for each program that have to be followed for the program to gain the accreditation grade. The institute must thus formulate a set of Course Outcomes and Program Outcomes for each course and program respectively. Till date the assessment criteria of most institutions to evaluate attainment of these outcomes has been limited to certain direct and indirect assessment tools or factors. But there are further assessment factors that have to be considered for a clear depiction of the attainment of outcomes. Integrating the Bloom's Taxonomy level, considering the correlation levels between each CO and PO and number of credits for each course are the factors discussed here under direct assessment, while MOOCs, internships, course end surveys, industrial

visits, patents, research work and mini projects are some of the factors discussed under indirect assessment. Thus, it ensures that the attainment levels of POs reflect a true picture on the skills developed by a technical skilled graduate.

Keywords: Attainment, Blooms Taxonomy, Course outcome, Direct and Indirect assessment, OBE, Program outcome.

1. Introduction

Graduate engineers are considered to be global citizens processing necessary professional skills suitable for the global scenario. Due to which the education system has witnessed gradual movement towards Outcome Based Education in recent decades, originating in Australia and South Africa and adopted by USA. The Indian education system has already adopted OBE in year 2013, with the local accreditation body, National Board of Accreditation, after signing the Washington Accord.

Education industry is one such industry which needs continues improvements. It certainly needs input from what the dynamic world needs. Hence most of the institutions are opting for Outcome Based Education. OBE is a way to structure content around activities that lead to demonstrate proficiency of a specific skill, knowledge, or behaviour.

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- OBE is non-perspective and starts by asking: what does a learner need to do to demonstrate mastery of a particular skill, knowledge and behavior. It is a student centered learning philosophy that focuses on empirically measuring student performance, which are called as outcomes. The four principles that characterize OBE are:
- Clarity of focus – Each course and program must have specific outcomes which gives a strong purpose for what each faculty or student does.
- Design down, deliver up – The desired or defined outcomes are designed and then according to defined outcomes, program curriculum, teaching and learning methodology and supporting facilities are designed.
- High expectations – OBE considers the fact that not all students learn at the same speed in the same manner and thus aims to equip students with varied learning systems.
- Expanded opportunities - Students are permitted to demonstrate their learning in different ways, and they must have numerous opportunities to demonstrate the outcomes, not just one.

A. Accreditation

Accreditation is a process of professional judgment, for evaluating whether the educational institution of programme meets specified standards of quality education. Accreditation helps in determining if an institution meets or exceeds these standards. It also helps students determine acceptable institutions for their admissions. There are two most widely recognized accrediting organizations in India are :

- 1) National Assessment & Accreditation Council (NAAC) mainly for institutional accreditation.
- 2) National Board of Accreditation (NBA) for programs offered in an institution.

B. National Board of Accreditation

NBA is now an autonomous body with the objective of assurance of quality and relevance of education, specially of the programs in professional and technical disciplines, i.e., Engineering and technology, management, architecture, etc though the mechanism of accreditation of programs offered by

technical institutions. NBA has introduced a new process, parameters and criteria for accreditation. These are in line with the best international practices and oriented to assess the outcomes of the program. Terms used here are :

- 1) Program outcomes (PO's):. They describe the complex performances a student should be capable of as a result of learning experiences within a program.
- 2) Course outcome (CO's): They describe what a student should be capable of at the end of learning the course.
- 3) Assessment: They are the processes carried out by the institution, that identify, collect and prepare data to evaluate the achievement of COs and hence the POs.
- 4) Attainment: Attainment here refers to the highest level of COs achieved with respect to POs.

C. Taxonomy Of Educational Objectives

Taxonomy is a system of classification which provides a unique point within the system for every item which is to be calculated. One of the most widely used ways of organizing levels of expertise is according to Bloom's Taxonomy of Educational Objectives. Bloom's Taxonomy uses a multi-tiered scale to express the level of expertise required to achieve each measurable student outcome.

The three taxonomies of blooms are:

- 1) The cognitive domain: Knowledge-Based Goals.
- 2) Affective domain: Affective goals.
- 3) Psychomotor domain: Skill- Based goals.

Hence for assessment, cognitive domain is used. The cognitive domain involves knowledge and the development of intellectual skills. There are six levels of cognitive processes which are:

- 1) Knowledge: To remember or to recall the information.
- 2) Comprehension: To understand or explain the information.
- 3) Application: To apply or solve the closed ended problems.

- 4) Analysis: To analyze or solve the open ended problems.
- 5) Synthesis: To evaluate or critically judging based on sound knowledge.
- 6) Evaluation: To create unique answers to problems.

The levels can be thought of as degrees of difficulties. The above classification for learning levels is based on increasing level of complexity.

2. Assessment Methods

The assessments instruments such as Semester End Exam (SEE), internals, mini-projects, assignments, quiz, etc these contribute to direct assessment method. As learning is a two way process, the whole system can not rely only on direct assessment method. Hence the indirect assessment instruments such as survey, industrial visits, internships, patent filed, product developed, publishing a research paper, adding a value added course, experts talk, etc can be considered.

A. Direct Assessment Method.

The CO assessment tools as shown in Table 1 is designed according to a course in an engineering program of an autonomous college.

To have a detail understanding of the concept, consider five course outcomes i.e., CO1, CO2, CO3, CO4 and CO5 in Subject 1. The weightage in the

As in the above table few cells are empty, these cells should not be considered in the distribution of

Key In the distribution of marks for direct assessment method

	Course Outcomes					TOTAL
	CO1	CO2	CO3	CO4	CO5	
SEE	20%	20%	20%	20%	20%	100%
LAB	20%	20%	20%	20%	20%	100%
INTERNALS 1	75%	25%				100%
INTERNALS 2		25%	50%	25%		100%
INTERNALS 3			25%	25%	50%	100%
SELF STUDY	20%	20%	20%	20%	20%	100%
QUIZ	20%	20%	20%	20%	20%	100%

OK

Fig. 1 Dialogue box for entering the distribution of marks for direct assessment method.

marks and final attainment of PO. below table are assumed values.

Table 1. Overall % Distribution of Marks.

Instruments	Weightage
Semester End Examination (SEE)	50%
Laboratory	15%
Internals (1,2 and 3)	20%
Mini-Project	10%
Quiz/Assignments	5%
Total	100%

1) Semester End Examination: In the present system, there are seven questions asked in SEE. These seven questions are not of same difficulty level, hence it is important to consider Bloom's taxonomy (as defined earlier).

Enter the CO's, Bloom's Level and Marks scored of each question in SEE

SL. No	1	2	3	4	5	6	7
Question 1	Question 2	Question 3	Question 4	Question 5	Question 6	Question 7	
CO							
Bloom's level							
Marks Scored							

OK

Fig. 2 Dialogue box for entering the CO's, Bloom's level and marks scored for each question in see.

The software will be capable of considering the different levels of Bloom's taxonomy and have a logic as mentioned in table 2.

The additional marks will contribute to extra 20% of actual marks scored. As mentioned in the above table, for a level 1 question, no marks will be added and for level 2 question $(1/5) \times 20\%$ of actual marks will be added and so on till level 6.

Table 2. Additional Marks For Different Levels of Question Asked.

Bloom's Factors	Additional Marks
For level 1	0.0
For level 2	Marks scored x (1/5)
For level 3	Marks scored x (2/5)
For level 4	Marks scored x (3/5)
For level 5	Marks scored x (4/5)
For level 6	Marks scored x (5/5)

Sample calculation:

Consider a question of level 4. The marks scored by the student are 15 out of 20.

$$\text{Additional Marks} = (3/5) \times (15) = 9$$

$$\text{Total Marks} = 15 + 9 \times 0.2 = 16.8.$$

2) Laboratory: The experiments that are carried out throughout the semester are designed to enhance the understanding of students. The different experiments contribute to different CO's. The distribution of marks in laboratory is figure 2.

Note: The total marks 25 are further reduced to 15.

Once the details are entered, the software will calculate the score for each CO and will consider weightage according to the figure 2. The score out of 25 will again be reduced to 15.3

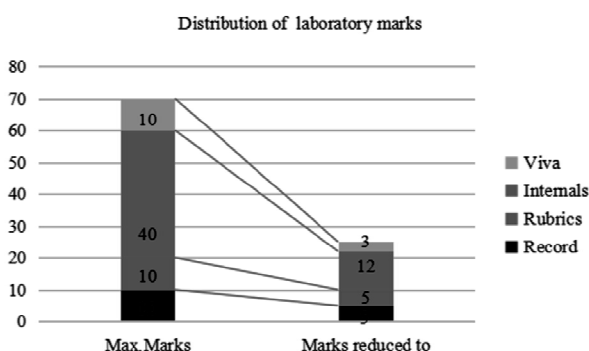


Fig. 2 Distribution of laboratory marks in a course.

Enter the Number of Experiments

Number of Experiments = 12

OK

Fig. 3. Dialogue box for entering the number of experiments in a course (say 12).

Enter the CO's, Marks scored in record and Rubrics.

Experiments	EX 1	EX 2	EX 3	EX 4	EX 5	EX 6	EX 7	EX 8	EX 9	EX 10	EX 11	EX 12
CO												
Marks for Record												
Rubrics												

OK

Fig.4. Dialogue box for entering the CO's, Marks Scored in record and rubrics of the experiments in a course.

Enter the details of Laboratory internals

Lab internals	Exercise (a)	Exercise (b)
CO		
Marks scored		
viva		

OK

Fig. 5. Dialogue box for entering the CO's, Marks Scored and viva voice of laboratory internals.

3) Internals: Assessment of internals are same as that of SEE. The institute conducts three internals and among the three internals best two will be considered by the software itself, this will encourage the faculty towards better attainment.

Similarly data will be entered for internals 2 and 3.

4) Self learning or Mini-Project: To map the scores of self learning component, the marks scored by the students will be equally distributed across the CO's covered.

Enter the CO's, Bloom's Level and marks score in Internals 1

	Question 1	Question 2	Question 3
CO			
Blooms level			
Marks scored			

OK

Fig. 6. Dialogue box for entering the CO's, Bloom's level and Marks Scored in internals 1.

5) Quiz: As weightage of quiz in final attainment is only 5%, stratification of marks scored according to CO's is avoided and marks will equally distributed over all the five CO's.

Enter the CO's and marks scored in Self Learning or Mini-Project.

Marks scored = _____

CO's Covered = _____

OK

Fig. 7. Dialogue box for entering the CO's and Marks Scored in Self Learning component.

This is shown for one student, the number of rows will be increased according to the class size. Once the entries are done the software will interpret the data and will calculate the attainment.

Fig. 8. Dialogue box for entering the marks scored in Quiz.

Table 3. Attainment levels

Percentage of students	Percentage to be obtained in a CO	Assigned Level of attainment
80% and above	90% and above	Level 5
65% and above	75% and above	Level 4
50% and above	60% and above	Level 3
40% and above	50% and above	Level 2
30% and above	40% and above	Level 1

B. Indirect Assessment Method

The instruments for indirect assessment are course end survey, alumni survey, employment survey, parent survey, research paper published, visits to industries, internship done by the students, product/service development, patent filed, an additional course done at private institutes by the students and other curricular activities. The actual learning of the student happens when they start exploring.

Students will give information to faculty for the below mentioned instruments and faculty can enter the scores in the dialogue box shown.

Weightage of Direct assessment and Indirect assessment methods:

As in all the four years of engineering the indirect instruments don't play equal role. It gradually increases from first year to final year. Hence the weightage should also be in the same manner.

Fig. 9. Dialogue box for entering the indirect assessment instruments response.

The Software by default will take 80% for Direct and 20% for indirect assessment.

3. Correlation of CO's To PO's

In a program, PO's will be achieved only if CO's are achieved. Set of CO's contribute to attainment of PO's. Hence it is of utmost importance that the CO's should be strongly related to the PO's. To include this factor, we can consider five levels of relation. Level

Weightage of Assessment Methods

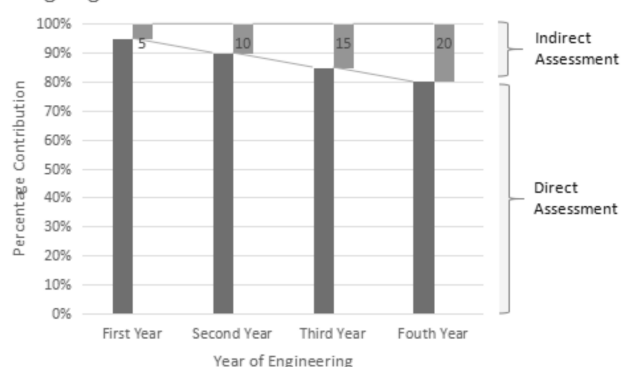


Fig. 10. Bar graph of percentage contribution of Direct and Indirect Assessment methods for the for years of engineering program.

one would mean the particular CO is least related to PO and level 5 would mean that the particular CO is strongly related to PO.

The Correlation can be decided by an external body such as an expert or any other member. The scores of the CO's which are strongly correlated of level of correlation to be 5, the score remain the same. On the other hand if level of correlation is 4 or less, the scores of CO will be reduced to 97.5% for level 4, 95% for level 3, 92.5% for level 2 and 90% for level 1.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

OK

Fig. 11. Dialogue box for entering the correlation level.

Similar calculations to be done for rest of the subjects handled by the faculty.

4. Reports Generated

The Final PDF generated through the software, shows the attainment levels of each CO to PO in a matrix form. It also highlights the best performing POs in green and those POs which have attainment level lower than Level 1 in red cells so that it is easy for the instructor to identify the weaker elements of the course outcomes and initiate the necessary changes to improve the attainment levels further. Therefore the software package helps reduce the clerical work of processing data to obtain the required attainment information.

5. Conclusion

The additional tools involved in the assessment instruments proposed in this paper help to balance the attainment levels obtained by considering the Blooms Taxonomy, levels of correlation and also the indirect assessment instruments. The change in weightage of direct and indirect assessment methods between year 1 and year 4 of the student reflects the changing needs for the way the student has to learn the outcomes related to the course. While year 1 concentrates more on the fundamental aspects and theoretical subjects, year 4 encourages students to interact more with

Faculty report on attainment of Course Outcome - Program Outcome.
Name : Prof. Mr AB

A. Subject Wise Report
Subject = Subject 1

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	4	3			2				1			
CO2				4			3				2	
CO3	3		2			1						3
CO4												
CO5	4				3					2		

Class Size = 60
 Number of students attempted SEE = 38
 Number of students attempted Internals 1 = 60
 Number of students attempted Internals 2 = 52
 Number of students attempted Internals 3 = 48
 Number of students attempted Laboratory Internals = 38
 Number of students carried Self Learning Component = 60
 Number of students attempted Quiz = 60

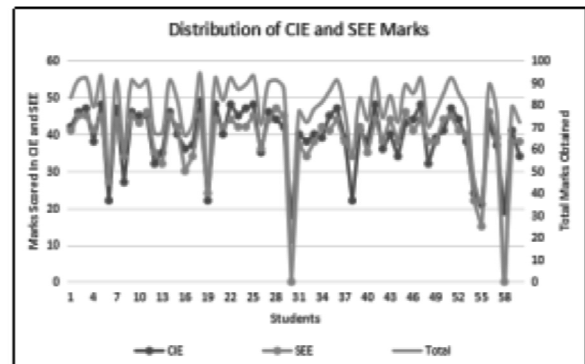
The best learner in class = Mr. X.
 The weak learner in class = Mr. Y.

Count of grades

Grades	Number of students
S	16
A	23
B	12
C	1
D	3
E	0
F	1
X	2

Graphs

1. Distribution of CIE and SEE Marks.



B. Condensed Report

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Subject 1	3	4	2.5	4	2.5	3	3					
Subject 2	4	3	3	4	2	3	1	2	2	2	3	
Subject 3	3	2		4	4	4	3					4
Average	4.3	3	3.33	4	3.25	3.5	3.55	1	2	2	2.5	3.5

	Number of Students		
Grades	Subject 1	Subject 2	Subject 3
S	16	13	14
A	23	22	23
B	12	15	10
C	1	2	1
D	3	2	1
E	0	1	0
F	1	2	2
X	2	1	2

Best Performance Subject : Subject 3
 Subject 1 needs improvements.

Fig. 12. A sample overview of report generated by the software.

industry experts and thus ensures that he is industry ready during graduation. The weightage for indirect assessment given here try to imbibe a holistic learning of the student towards the specified course outcomes by increasing the importance towards various indirect methods like mini projects, internships, research papers, industrial visits and extra-curricular activities.

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