Outcome Based Education: An empirical approach

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***Abstract*—The outcome based education is student centric approach where the student's performance are measured to justify the curricula and teaching learning process with the help of appropriate assessment tools. Based on the outcome assessed the curricula can be modified by identifying the areas in which students are to be strengthened. Each educational institution defines their own outcomes and use their own approach to measure students' performance based on their outcomes. OBE doesn't have set of protocols to follow instead the institution will follow its own procedure to measure students' performance. In OBE we measure what students have learnt using gathered evidences like marks in tests, quizzes, projects, self-study etc. and identify what they were supposed to learn which in turn will help in enhancing/modifying the course. This paper discusses an approach to find the course attainment and program attainment through which we can assess our student's performance.**

Keywords—OBE, CO attainment, PO attainment, PEO

I. Introduction

Many educational institution have adopted their own approach to define Outcome Based Education[1,2,3,4]. This paper discusses the approach followed by department of CSE in our college. The results of outcome based education [5] indicates the performance of our educational policies/system and which will in turn help in updating the curriculum in the areas the program is lagging behind. We can also determine/analyse the performance of individual student and help him in strengthening his/her weakness. Outcome based education[6] concentrates on evaluating students' performance empirically based on the achievement of predetermined outcomes. These outcomes are attained using multiple attributes such as Tests, quizzes, Self-study, Laboratories, projects and assignments. Each program in an educational institution defines their own program outcomes and each course in a program is defined with its own course outcomes. The general framework of OBE is shown in Fig. 1. OBE is defined using four layers. Layers of Outcome Based Education (OBE) are

- Vision and Mission: Each department will have its own Vision and Mission and outcomes achieved should be consistent with Mission.
- Program Educational Objectives (PEO): PEOs are specific to each program in a department. Suppose department runs two different programs each program will have its own PEOs defined. The PEOs are measured after the employment.
- Program Outcomes (PO):POs are specific to each program and they define the attributes the graduates are required to attain at the time of graduation.
- COs: are specific to individual course. The students are required to attain the COs for each course.

The Course Outcome (CO) attainment of each course will help in deriving the Program Outcome (PO) attainment for entire program which in turn derives the Program Educational Objective (PEO) attainment. The PEOs are defined based on direct and indirect methods where direct method involve the standard procedure of Tests, quizzes, assignment, self-study and Laboratory. Indirect method is through surveys from exit, alumni, internship, employer and higher education.

Fig.1. Structure of Outcome Based Education(OBE)

II. Background

A technique to find CO attainment is developed using Microsoft Excel sheet in [7]. This software is used to analyze the attainment of course outcomes, based on the analysis further action is taken. They use different assessment tools such as final exam, tests and projects. This approach considers total marks of each student instead of individual students' marks in each question to find the attainment. Assessment of learning outcomes are discussed in[8]. Further it discusses about different assessment tools for direct and indirect methods.

The students' performance at the course level is improved first and the overall impact of the program at college level is demonstrated in [9]. The pros and cons of OBE is highlighted in [1]. It provides an overview of the key characteristics of Outcome Based Education and its application in various contexts. Paul D. Camp Community College Student Outcomes Assessment Plan is discussed in [2]. The student outcomes assessment ensures faculty-based evaluation for the purpose of improving the quality of the college's courses/instructional programs and ensuring that outcomes achieved are consistent with the mission of the college.

This paper discusses the approach followed by Department of CSE, R V College of Engineering to assess course outcome and program outcome to ensure and improve the quality of education.

III. Metrics Used For Evaluating Obe

The OBE is defined by many factors. Educational institutions follow their own techniques to define OBE. Similarly our department has followed an approach used to define OBE which is the interest of this paper. The factors influencing OBE are as follows

A. Course Achievable Matrix

Course is prepared along with the course outcomes for each course. The course outcomes are designed based on the Bloom's taxonomy. The syllabus is mapped with course outcome through which we can get course achievable matrix. Course achievable is a value which defines the percentage of course outcomes that are achieved through the syllabus.

B. Question Paper Mapping

Each question in question paper is mapped to the course outcomes of that course which in turn used to find course attainment. The ratio of these two (question paper and course achievable) will give the % of course outcome to be achieved by each course by the students(X).

C. CO Attainment

CO attainment is obtained by the ratio of students score to X.

D. CO-PO Mapping Matrix:

Course Outcomes are mapped to Program Outcomes in scale of H (High), M (Medium) and L (Low).

E. Program Outcome Attainment:

Using the CO-PO mapping matrix PO attainment is calculated.

F. Program Educational Objective (PEO) Attainment

Using PO attainment of all the subjects, Major Project and Surveys (Exit, Alumni, Higher Education and Employer) PEO attainment is calculated. Following is a course which we have showcased for CO, PO attainment. The same has been followed for all the courses.

IV. CO Attainment Approach

Course Outcome attainment illustrates the performance of a student in a particular course. CO attainment is calculated using students mark in that course. To calculate CO attainment we consider the marks of each question in the question paper for all the three tests. Following text discusses the procedure followed to find CO attainment.

1. Course is prepared along with the course outcomes for each course. The course outcomes are designed based on the Bloom's taxonomy. The syllabus is mapped with course outcome through which we can get course achievable. Course achievable is a value which defines the percentage of course outcomes that are achieved through the syllabus. Figure 2 illustrate the course achievable matrix.

Units	CO1	CO2	CO3	CO4	TOTAL COS
1	2	2	3	0	7
2	1	1	1	4	7
3	2	2	1	3	8
4	1	2	0	1	4
5	3	2	3	2	10
Total COs	9	9	8	10	36
Achievable CO1					25.00
Achievable CO2					25.00
Achievable CO3					22.22
Achievable CO4					27.78

Fig. 2: Course achievable matrix

Number of topics mapped to particular course outcome COj is given by (1)

$$TCOj = \sum_{u=1}^{t} Tju \quad (1)$$

In equation (1)

- TCOj represents the topics mapped to COj in syllabus.
- t represents number of units in the syllabus.
- Tju represents the topic mapped to COj in unit u.

For example number of topics mapped for CO1 in unit 1, 2, 3, 4, 5 are 2, 1, 2, 1, 3, 9 respectively defined by T11,T12,T13,T14,T15 which derives TCOj value as 9. Number of topics in the syllabus is given by (2).

$$TCO = \sum_{j=1}^{n} TCOj \quad (2)$$

In equation (2)

- TCO represents sum of all the topics in the syllabus.
- n represents number of COs
- j represents jth CO (COj)

For example as shown in Fig. 2 values of TCO1 , TCO2, TCO3, TC04 is given by 9, 9, 8, 10 respectively which adds to 36.

Course achievable ACOj for each course outcome COj is given by

$$ACO\,j = TCO\,j \,/\, TCO \quad (3)$$

In equation (3)

- ACOj represents course achievable for COj.
- TCOj represents number of topics mapped in syllabus for COj.
- TCO is the number of topics in syllabus.

For example course achievable for CO1 (ACO1) is 9/36 which is equal to 25%.

2. Each question in question paper (Test, quiz, assignment, and self-study) is mapped to the course outcomes of that course. Each question in internal question paper is mapped to appropriate course outcome. Figure 3 represents the mapping of question paper (Test1, Test2, and Test3) questions to the course outcome. First row (MAX MARKS Q1 AND TEST1) represents the maximum marks in each question in first test and quiz. Second row(MAPPING OF CIE 1) represents mapping of course outcomes to each question. For example question1 in quiz1 is mapped to CO1 and question2 is mapped to CO4. Total marks for each CO in question paper is given by (4)

Particular	QUIZ															TEST								
No. of QUESTIONS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	1a	1b	2a	2b	3a	3b	4a	4b	5a	5b
MAX MARKS Q1 AND TEST1	1	1	1	2	2	2	2	2	2	2	0	0	0	0	0	0	10	0	10	0	7	3	10	0	6	4
MAPPING OF CIE I	2	1	1	3	3	3	2	2	4	0	0	0	0	0	0	3	0	4	0	2	3	4	0	4	1
MAX MARKS Q2 AND TEST2	1	1	1	1	1	2	2	2	2	2	0	0	0	0	0	2	8	10	0	5	5	7	3	5	5
MAPPING OF CIE II	2	4	3	1	1	2	1	1	4	4	0	0	0	0	0	1	2	3	0	3	3	3	1	3	4
MAX MARKS Q3 AND TEST3	2	2	2	2	1	1	1	2	2	0	0	0	0	0	0	6	4	7	3	7	3	5	5	5	5
MAPPING OF CIEIII	1	2	1	3	4	1	4	2	3	0	0	0	0	0	0	4	1	2	2	3	1	3	4	4	3

Fig. 3: Mapping of question paper to COs

$$QCOj = \sum_{T=1}^{3} MQCOj \quad (4)$$

In equation (4)

- j represents CO number in the course.
- MQCOj represents the marks of questions mapped to COj in each test.
- QCOj represents the total marks mapped to COj in all the three tests.

For example in Fig. 3 total marks of CO1(MQCO1) in Test 1 is 6, MQCO2 is 12. QCO1 is 29 which is obtained by adding MQCO1 in Test1, Test2 and Test3.

3. The ratio of these two will give the % of course outcome to be achieved by each course by the students

$$XCOj = \frac{QCOj}{ACOj} \quad (5)$$

In equation (5)

- QCOj and ACOj represents the values derived in (4) and (3) respectively.

4. CO attainment is obtained by considering student marks in each question as shown in (6) and Fig.4 indicates the marks entries of each student in three tests for each question. Since questions are mapped to COs the ratio of total score of all the students for a particular CO to course achievable for that CO will give the CO attainment as in (7).

$$SCOj = \frac{\sum_{i=1}^{N} MCOj}{N} \quad (6)$$

In equation (6)

- MCOj represents marks scored by a student for COj.
- N represents number of students in the course.
- SCOj represents average score of students for COj

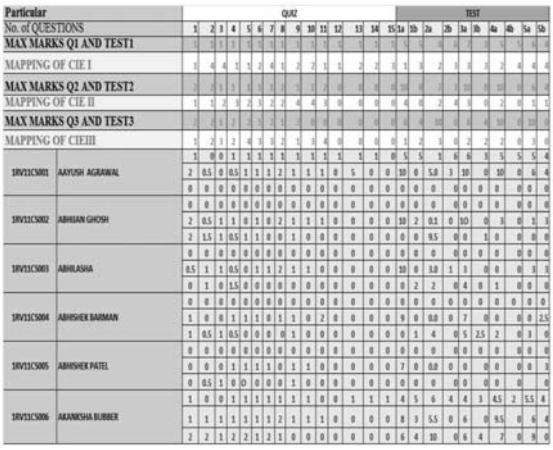

Fig. 4. An excel sheet for students marks entry

Finally CO attainment for jth CO is calculated using (7)

$$COj = \frac{SCOj}{XCOj} \quad (7)$$

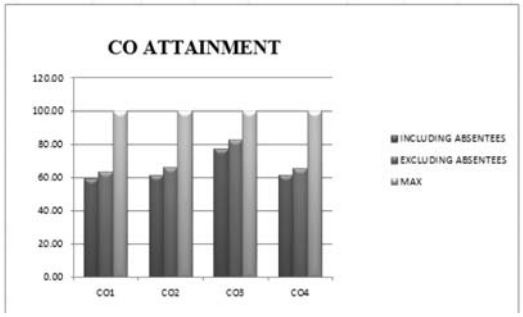

Fig.5. CO attainment including and excluding absentees

Figure 5 illustrates the attainment of course outcomes including and excluding absentees. It concludes that the attainment for excluding absentees will be more compared to including absentees.

V. PO Attainment Approach

Program Outcome attainment defines the performance and achievement of a student in the program. The following text defines the way in which the PO attainment is calculated.

a. To calculate PO attainment it is required to map the Course Outcomes with the Program Outcomes defined by the program in scale of High (H), Medium(M), Low(L). The CO-PO mapping matrix is as shown in Fig. 6.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1	L	L	H	L	L	H	L	H	M	L	L	M	L
CO2	L	H	L	L	H	L	L	M	M	L	L	L	L
CO3	L	H	L	L	M	L	L	M	M	M	L	H	L
CO4	H	L	H	L	L	M	L	M	M	L	L	L	L

Fig. 6: CO-PO mapping matrix

b. For each CO and for each PO, attainment is calculated provided that COj is mapped to POij.

$$POij = \frac{Sf * COj}{Sf * 100} = \frac{COj}{100} \quad (8)$$

In equation (8)

- POij represents POi attainment for COj.
- Sf represents scale factor.

For example in Fig. 7 PO1 attainment for CO1 is 17.68 for including absentees and 18.99 for excluding absentees.

PROGRAM OUTCOME FOR EACH COURSE OUTCOME(Includes absentees)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1	17.68	17.68	58.93	17.68	17.68	58.93	17.68	58.93	29.47	17.68	17.68	29.47	17.68
CO2	18.42	61.41	18.42	18.42	61.41	18.42	18.42	30.71	30.71	18.42	18.42	18.42	18.42
CO3	23.05	76.85	23.05	23.05	38.42	23.05	23.05	38.42	38.42	38.42	23.05	76.85	23.05
CO4	61.11	18.33	61.11	18.33	18.33	30.55	18.33	30.55	30.55	18.33	18.33	18.33	18.33
	30.07	43.57	40.38	19.37	33.96	32.74	19.37	39.65	32.29	23.21	19.37	35.77	19.37

PROGRAM OUTCOME FOR EACH COURSE OUTCOME(Excludes absentees)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1	18.99	18.99	63.31	18.99	18.99	63.31	18.99	63.31	31.66	18.99	18.99	31.66	18.99
CO2	19.79	65.97	19.79	19.79	65.97	19.79	19.79	32.99	32.99	19.79	19.79	19.79	19.79
CO3	24.77	82.56	24.77	24.77	41.28	24.77	24.77	41.28	41.28	41.28	24.77	82.56	24.77
CO4	65.65	19.69	65.65	19.69	19.69	32.82	18.33	32.82	32.82	19.69	19.69	19.69	19.69
	32.30	46.81	43.38	20.81	36.49	35.17	20.47	42.60	34.69	24.94	20.81	38.43	20.81

Fig. 7. Automated PO attainment Excel sheet for each CO

c. Finally the average of all COs for a particular PO will give the PO attainment as shown in (9)

$$POi = \frac{\sum_{j=1}^{n} POij}{M} \quad (9)$$

In equation (9)

- M denotes the number of COs mapped to particular POi. Example if out of four course outcomes if only CO1 and CO3 are mapped to PO1 then M value for calculating attainment for PO1 will be 2.

Similarly we calculate PO attainment for all POs using (9). Fig.8 indicates the PO attainment for all POs.

PROGRAM OUTCOME ATTAINMENT(Includes absentees)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO's	63.30	67.03	62.12	64.57	64.69	62.36	64.57	63.45	64.57	66.33	64.57	68.13	64.57
	68.00	72.01	66.74	69.37	69.50	67.00	68.24	68.16	69.37	71.26	69.37	73.19	69.37

PROGRAM OUTCOME ATTAINMENT(Excludes absentees)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO's	68.00	72.01	66.74	69.37	69.50	67.00	68.24	68.16	69.37	71.26	69.37	73.19	69.37

Fig. 8. Automated PO attainment Excel sheet

Graph in Fig.9 indicates the PO attainment for all POs including and excluding absentees.

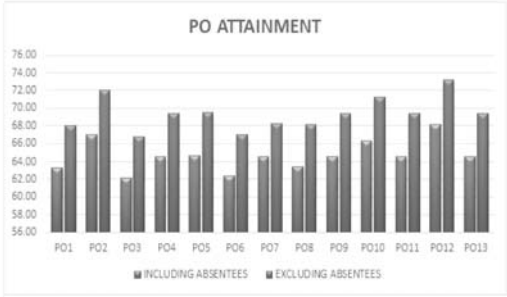

Fig. 9. PO attainment including and excluding absentees

VI. PEO Attainment

The Program Educational Objectives (PEO) was derived through direct involvement of faculty. The Program Educational Objectives are designed to meet the needs of the constituents that hire our graduates (industry) and the constituents who design and deliver content (faculty) in a manner consistent with the mission of R V College of Engineering and in a manner that will benefit our students.

The PEO attainment is calculated with the help of direct and indirect methods. The direct method involves the PO attainment of all the subjects including major project. Indirect method involves considering the feedback from exit survey, alumni survey, higher education, internship and employer surveys.

VII. CONCLUSION

An approach to calculate attainment for CO and PO has been discussed in this paper. An Excel sheet is prepared to automate the process of CO and PO attainment. Attainment for both CO and PO are calculated by including absentees and also excluding absentees which concludes that the attainment will decrease if the numbers of absentees are more. This approach is developed for assessing only internal marks but this can also be extended to add external marks for calculating the attainments. This approach will help the faculties in identifying students who didn't learn what they were expected to learn in 1st test and train them in those areas for better performance. Finally the attainment of each course will be evaluated which will help in reviewing the course and its structure.

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