Assessment of Program Outcomes Using Direct and Indirect Methods

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Abstract—**Outcome based education (OBE) has been adapted in major education institutions particularly in engineering education. This has been used extensively since the National Board of Accreditation (NBA) has made it mandatory for program accreditation. The OBE focusses on outcomes of the program rather than curriculum framed for the courses. Outcomes may refer to the knowledge or Skill gained, competency and employability of the graduates of the program.**
In order to achieve this outcome, the syllabus has to be carefully and meticulously planned with scope for continuous improvement. In the Department of Electronics and Communication, BMS College of Engineering, Bangalore, We have adopted the OBE system. This paper aims to provide the evaluation process in our department to measure the outcomes. For each course, the course outcomes (COs) are methodically articulated keeping the focus on Program outcomes (POs) that are defined by the NBA.

Index Terms—NBA, OBE, COs, POs.

I. INTRODUCTION

Outcome based education (OBE) program emphasizes on clear declaration of learning outcomes stated as course outcomes and program outcomes that identifies the tasks that the students are expected to achieve after completion of the program. In [1], Oliver Au and Reggie Kwan have expressed that OBE teaching learning program will not be effective unless it is supported by suitable teaching, learning and assessment tools.

OBE offers a powerful and effective way of implementing education in engineering through cutting edge curriculum development. In [2], Geoff Brindley remarks on the increasing pressure from governments on educational institutions worldwide to demonstrate their efficiency by rigorous reporting of program outcomes by implementing OBE. In [3], Vijayalakshmi M. et al. have shown assessment rubrics and Matrix for capstone project evaluation in OBE. In [4], Tanveer I Bagban et al. has carried out a survey and compared the various assessments methods for OBE. He feels that traditional assessment methods may not work for modern education systems. RashaEldeeb and NishaShatakumari in [5] have discussed the pitfalls in implementation of OBE and suggested guidelines for effective implementation. In his

paper [6], O R S Rao has stressed the need for OBE in Indian technical institutions and opines that its successful implementation is a determined effort of all the stake holders. In [7], D.R Kalbande and SS Rathod have developed an application that automates the process of preparing the course file to evaluate the Program and course Outcome that helps the faculty in finding the existing gap to keep up the academic standard as high as possible.

In this paper, the evaluation and assessment of outcomes has been formulated based on OBE as prescribed by NBA.

II. COURSES AND SYLLABUS FRAMING TO ACHIEVE PROGRAM OUTCOMES

The syllabus framing is carried out with lot of forethought given to Program Outcomes (POs). In our department, Courses are categorized as shown in Figure 1.
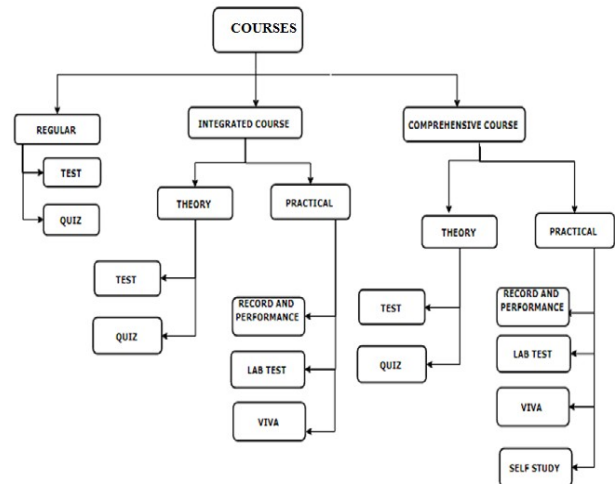

Figure 1. Categorization of courses and their assessment tools

There are three types of courses designed, one is regular or normal that has only one component - theory or practical, the other is Integrated Course that has two components - both theory and practical and the third is Comprehensive course that has three components - theory, practical and self-study.
The curriculum for the courses is designed considering quality of education with conducive learning environment having scope for research and continuous improvement.

The Department Advisory Board (DAB) ensures that each course contributes to a set of Program outcomes and thereby all the POs are attained through different courses.

III. METHODOLOGY FOR EVALUATION OF COURSE OUTCOMES

Evaluation process for Course Outcomes (COs) involves:
1. Direct Assessment
2. Indirect Assessment

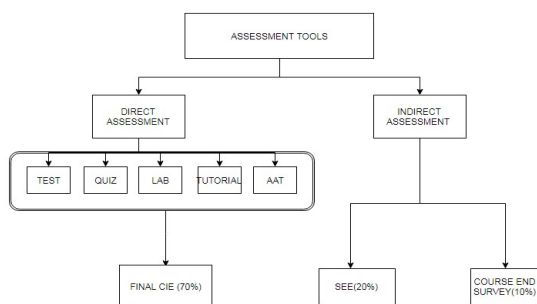Figure 2. depicts the assessment tools for evaluation of program outcomes.

Figure 2. Assessment tools for evaluation of outcomes with weightage

Direct Assessment (shown in Figure 2) involves Continuous Internal evaluation (CIE) of each student through various processes that are listed below

Test: The CIE assessment is done based on student"s performance in the three tests, out of which best 2 test marks are considered. Each Question in the test is framed to map to a particular CO and hence to a particular PO. This way, all the COs are targeted through framing proper questions in the tests.

Quiz: Multiple choice questions (MCQ) are framed to assess the analytical skills of the students. Here again, each MCQ maps to a particular CO and PO.

Laboratory: Students perform a set of experiments that ensemble the curriculum and are continuously evaluated. Also, at the end of the semester, analytical and design skills of the students are evaluated through test/ Open ended experiments or Mini projects. These experiments will help in analysing whether the student can understand the problem statement, will be able apply the concepts learnt and analyse the results.

Tutorial: Analytical skills are inculcated in students through tutorials where students are given regular exercises/assignments.

Alternate Assessment Tools (AAT): In some of the courses, Course instructors have introduced Alternate Assessment methods such as Seminars, Mini-Projects, Assignments, Case studies, etc. in place of regular assessment tools. These assignments aim to understand whether the student can understand the problem statement, will be able apply the concepts and analyse the results and also suggest optimization if possible.

Indirect Assessment involves the student performance in Semester End Exam (SEE) and Course End Survey (CES). Again, in SEE, the questions are framed such that they map to particular COs and POs. However, since the marks obtained by each student for each question is not made available in our

system for the faculty evaluating the outcomes, this assessment falls under indirect assessment category. The COs are said to be attained if 60% or more students, obtain 60% marks in SEE.

CES are a set of questions that are framed to get student feedback on the course. This feedback is taken at the end of the course. The questions are framed keeping in mind the COs and hence the POs. Finally, CES analysis is done to obtain CO attainment through Surveys.

The weightages of various components of CIE for regular or normal courses is shown in the table below:

TABLE I
Assessment Pattern for Regular/Normal Courses

COMPONENT	THEORY		TOTAL MARKS
Type of Assessment	Test*	Quiz# or AAT	
Max. CIE Marks	40	10	50

The weightages of all components of CIE for integrated courses is shown in the table below:

TABLE II
Assessment Pattern for Integrated Courses

COMPONENT	THEORY		PRACTICAL			TOTAL MARKS
Type of Assessment	Test*	Quiz#/AAT	Records & Performance	Lab Test	Viva-voce/AAT	
Max. CIE Marks	20	05	10	10	05	50

The weightages of all components of CIE for comprehensive courses is shown in the table below:

TABLE III
Assessment Pattern for Comprehensive Courses

Component	Theory (50%)		Practical (30%)		Self-Study (20%)	TOTAL MARKS
Type of Assessment	Test*	Quiz#	Lab Performance/ Record	Lab Test	AAT	
Max. CIE Marks	20	05	10	05	10	50

If AAT is used, the concerned teacher decides the pattern of assessment before the commencement of the classes by taking prior approval from Board of Studies (BOS).

*Three tests will be conducted; best two tests will be considered for final assessment.

One quiz will be conducted if there is AAT and if not, two quizzes will be conducted [8].

IV. PROCEDURE OF EVALUATING CO ATTAINMENT AND PO ATTAINMENT

Here, a case study of a sample course is considered for evaluation of CO and PO attainment, which has all the three components i.e, Theory, Practicals and Self study component.
Course Title: Microcontrollers
Semester: IV
Course Code: 15ES4GCMCS
Credits: 3-0-1-2
The Course outcomes (COs) for this course is shown in the table below.

TABLE IV

Couse Outcomes for the Course 15ES4GCMCS

CO-1	Apply the programming concepts to provide solution to a given problem using embedded „C"/assembly program
CO-2	Analyse the given data to program the device for time critical application
CO-3	Design a system for control application using 8051 to perform multiple tasks
CO-4	Use simulator to debug and execute assembly and embedded C code.
CO-5	Engage in self-study to design a system to demonstrate the applications of microcontroller for health, safety, environment and society.

The COs are mapped to Program Outcomes (POs) as shown below in table V. The weightages given to each PO indicates the level of expected attainment in that course. Here, 3- high attainment level, 2- medium attainment level and 1- low attainment level expected.

TABLE V
Mapping of Course outcomes with Program Outcomes for the Course 15ES4GCMCS

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

Table VI gives the marks allotted for various COs in the Assessment tools described above.

TABLE VI
Assessment Analysis for 15ES4GCMCS

	CO 1	CO 2	CO 3	CO 4	CO 5	Total
Test -I	05	13	10			28
Test-II	06	16	10			32
Test-III	16	06	10			32
Quiz-I	10	10				20
Lab				15		15
Self-Study					10	10
Total	37	45	30	15	10	137
Percentage	27%	33%	21%	12%	7%	100%

Figure 3 shows the marks distribution among the students obtained through CIE for the sample subject 15ES4GCMCS.
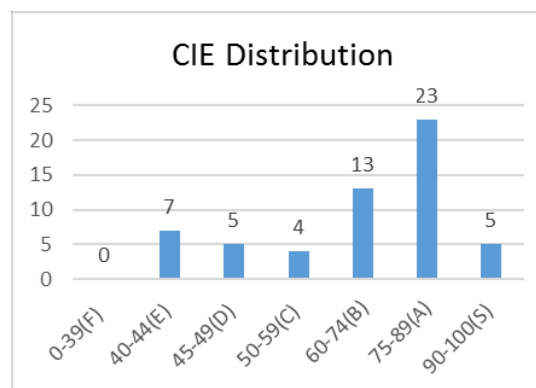

Figure 3. Marks distribution in CIE for 15ES4GCMCS

Figure 4 shows the marks distribution among the students obtained through SEE for the subject 15ES4GCMCS.
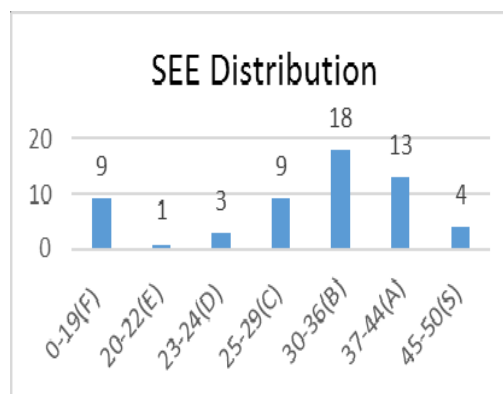

Figure 4. Marks distribution in SEE for 15ES4GCMCS

The courses in the curriculum are defined by a set of measurable statements called Course Outcomes (COs) which contribute to the assessment of Program outcomes.

The course outcomes clearly describe the knowledge, application, analytical and design skill for a given course. In addition using alternate assessment tools one can measure skillsets like communication, documentation, team work, presentation or continuous learning. The course outcomes are written by course coordinator and course instructors handling the courses. Once framed these course outcomes along with the curriculum are placed before the Board of studies and Department Advisory Board for approval with suitable suggestions. Final curriculum with course outcomes is presented in Academic council meeting. They are then published in college website and curriculum books.

The assessment process for evaluating COs in our system are listed in table V along with weightages given for attainment.

TABLE VII

Assessment process for evaluating COs

Sl.no	Assessment method	Direct/Indirect	Weightage (%)
1	Continuous Internal Evaluation (CIE)	Direct	70%
2	Semester End Exam (SEE)	Indirect	20%
3	Course End Survey	Indirect	10%

A. Procedure for obtaining CO through CIE

Table VIII shows CO attainment through CIE for the sample subject 15ES4GCMCS taken for case study. This subject has 5 course outcomes that are listed in table IV. This attainment level is the average attainment of all the assessment tools that were used for CIE.

TABLE VIII
CO attainment through CIE for the subject 15ES4GCMCS

CO No	Attainment
CO1	0.69
CO2	0.68
CO3	0.61
CO4	0.75
CO5	0.82

B. Procedure for obtaining CO through SEE

CO attainment is calculated for SEE by considering the percentage of students who have scored 60% or more in SEE for each course as this falls under indirect assessment in our institution.The students securing S, A & B grade in SEE are considered out of the total number of students who have taken the SEE. The attainment level is number of students scoring greater than or equal to 60% of maximum marks. This attainment level maps to all COs of that course and in turn to all the PO's mapped to the COs.

Formula for obtaining CO through SEE is as shown in table IX.

TABLE IX
Formula for CO attainment through SEE

Number of students	Weightage	Attainment
S grade	10	S*10 (M)
A grade	9	A*9 (N)
B grade	8	B*8 (O)
Total number of students (T)	10	T*10 (D)
Formula = (M+N+O)/D		

Table X shows Course outcomes through SEE for the sample subject.

TABLE X
CO attainment through SEE for the subject 15ES4GCMCS

CO No	Attainment
CO1	0.53
CO2	0.53
CO3	0.53
CO4	0.53
CO5	0.53

C. Procedure for obtaining CO through CES

Course-end survey (CES) is the response taken from the students to a set of questions framed by the course Instructor/coordinator which are mapped to course outcomes. Course End survey is a feedback obtained from students at the end of the course to attain continuous improvement in teaching-learning process. The Course End survey also contributes to CO attainment.

Formula for obtaining CO through CES is as shown in table XI.

TABLE XI
Formula for CO attainment through CES

Number of responses	Weightage	Attainment
Excellent (E)	5	E*5 (M)
Very Good (V)	4	V*4 (N)
Good (G)	3	G*3(O)
Fair (F)	2	F*2(Q)
Poor (P)	1	P*1(R)
Total number of samples (T)	5	T*5 (S)
Formula = (M+N+O+Q+R)/S		

Table XII shows Course outcomes through CES for the sample subject.

TABLE XII
CO attainment through CES for the subject 15ES4GCMCS

CO No	Attainment
CO1	0.82
CO2	0.82
CO3	0.83
CO4	0.85
CO5	0.83

D. Procedure for obtaining final CO Attainment

The overall Course Outcome is obtained by the sum of Course Outcome through CIE, Course Outcome through SEE and Course Outcome through Course End Survey. The final CO attainment is shown in the table XIII with suitable weightages

given. Direct assessment methods are given more weightage for CO attainment.

TABLE XIII
Final CO attainment

Sl.no	Assessment method	Direct/Indirect	Weightage (%)
1	Continuous Internal Evaluation (CIE)	Direct	70%
2	Semester End Exam (SEE)	Indirect	20%
3	Course End Survey	Indirect	10%

The Table XIV shows the final CO Attainment for the subject 15ES4GCMCS considering the CIE, SEE and CES.

TABLE XIV
Final CO attainment for the subject 15ES4GCMCS

COs	CIE - 70%	SEE - 20%	CES - 10%	TOTAL
CO1	0.48	0.16	0.082	0.72
CO2	0.48	0.16	0.082	0.72
CO3	0.42	0.16	0.083	0.66
CO4	0.52	0.16	0.085	0.77
CO5	0.57	0.16	0.083	0.81

E. Procedure for attaining PO through CO Attainment

The PO attainment level is described as 70% or more number of students scoring greater than or equal to 70% of maximum marks as described by the BOS. Program outcomes are attained through Course Outcomes for all the courses in the curriculum.

For every batch of students, program outcomes are obtained through course outcomes of all the courses that the student takes up. As an indirect assessment, exit survey is conducted for each batch at the end of the program to take their feedback. Finally, the PO attainment for the outgoing batch is evaluated by taking the CO attainment for all the courses and also considering the exit survey, Alumni survey and employer"s survey as suggested by NBA.

V. Conclusion

This paper discusses the process of evaluating attainments of Course outcomes and hence the Program outcomes for the courses designed in the department of E&C, BMS college of Engineering. This methodology provides an effective way of evaluating COs and POs in the present existing system that is followed in our college. The Program Outcomes of the courses are evaluated using the direct and indirect assessment methods defined by the NBA. As the College and the department is going through a continuous improvement cycle, the processes described here also may undergo further

improvements in achieving Program outcomes. OBE has facilitated the faculties to assess the student"s performance by developing innovative ways by using various assessment tools. This has led to an improvement in the teaching learning process and attain better PO levels which in turn has helped the students to achieve better academic performance as well as better equip them to face challenges in their professional and personal life.

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