

A EMPIRICAL STUDY ON CO-PO ASSESSMENT & ATTAINMENT FOR NBA TIER-II ENGINEERING ACCREDITATION TOWARDS EMPOWERING THE STUDENTS THROUGH OUTCOME BASED EDUCATION

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Abstract:

According to John Dewey, an American philosopher, psychologist and educational reformer, "Education is not preparation for life, education is life itself". Education is a form of teaching-learning-practicing in which the knowledge, skills and information are transferred from teachers to students. But the traditional system of education fails to measure the capability of the students. It only assesses the students learning by allowing them to reproduce the exact text presented in the text book as answer for questions. But the real need and demand of twenty first century learning system is the transition from *Output Based Education* to *Outcome Based Education*. Outcome Based Education (OBE) system is able to measure what the students are capable of doing. Indian education system has introduced the Outcome Based Education System through National Board of Accreditation (NBA). This is a model which not only gives much better technical knowledge to twenty first century Engineers, but also gives emphasis on the development of affective domain attributes which are needed in workplace, e.g. interpersonal skills, analytical skills, computer skills, organizational skills, leadership skills, self-confidence, creativity, strong work ethics, motivation, initiative, flexibility, adaptability and entrepreneurial skills. This paper proposes OBE system of NBA TIER II accreditation in engineering colleges [1-3]. NBA has been highlighting ten different criteria to provide OBE in Engineering program with different prospective. This paper suggests various course delivery methods to attain OBE in Engineering Program, presents assessment methods, attainment of course outcome (CO) and program outcome (PO) and also covers NBA specified criteria 2, 3 and 7. Sample calculations for various assessment methods are also included in this paper for the evaluation of CO and PO.

Keywords: Outcome Based Education (OBE), Course Outcome (CO), Program Outcome (PO), CO-PO

Mapping, CO Assessment, PO Assessment, CO Attainment and PO Attainment.

I. Introduction

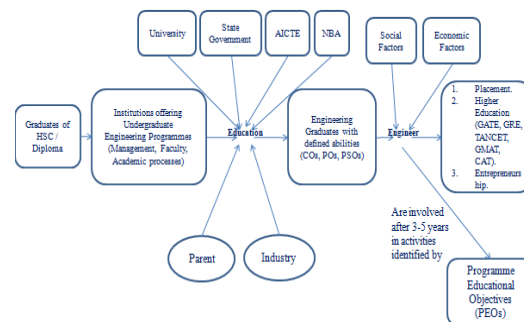


Figure1: Outcome Based Education

"Scientists investigate that which already is; Engineers create that which has never been" is a famous quote by Albert Einstein which makes grace in engineering among the world. After completing the higher education, a student who chooses an Engineering domain should have to undergo different phases in education system. After choosing a particular program for studying engineering, he/she has to enter in to the institution. The institution will have a vision which is the root cause for producing qualified engineers. The institution will set mission according to organizational objectives. The vision and mission are concluded by governing board council members of the institution. Stakeholders are the advisory members of the institution. The stakeholders are classified in to two as internal and external stakeholders. The internal stakeholders of an institution include management, governing council members,

faculty members, non-teaching staff and students. The external stakeholders are parents, employers, industrial experts and alumni. The management of the self-financing engineering institution will provide financial support and give a hand in administrative level functioning of the institution. The university gives affiliation to the institution after fulfilling the norms. Later the institution will obey the regulations and curriculum released by the university. Normally the curriculum of the university is decided by members of board of study which is based on fundamental concepts, recent trends, applications in the technology and also industrial needs. The faculty member of the institution handling the classes is to deliver the curriculum to the students. The institution will have Industry Institute tie-up. The university functions under the control of the state government with the norms of All India Council for Technical Education (AICTE). AICTE fix the norms for the institution, for the faculty members and for the students who enters into engineering domain. NBA grants the accreditation to the program which should be fulfilled the norms of NBA. The student who completed the engineering degree should get opportunities to place in core companies, to pursue higher education by attending GATE/TANCET/IELTS/other exam(s), to get government jobs through attending civil services examination and to become technological entrepreneur. The grandaunts can choose any of the above mentioned which will be based on the knowledge, social factor, economical factor and family situations. This determines the achievement of the Program Educational Objectives (PEO) of the institution. The whole gives the student to the proper guidance for the education.

The outcome and purpose of an education is what the student should be able to do after completion of a program or a course. Outcome-based education focuses every part of the educational system around goals or outcomes. As the term used is outcome, it should be accessed through the specified parameters. So, the evaluation of outcome of the program should be the overall measure of knowledge, skill, attitude as well as proficiency towards the attainment of the goal upon completion of a program and after four years of graduation study. To attain the benefit of the OBE, there is no single specified style of teaching or assessment methods to be followed in OBE system. It is by delivering the content through conventional and/or active learning methodologies which can be adopted based as per the requirements. Some of the conventional methodologies are power point presentation, assignment, seminar, case study, guest lecture, workshop., etc., and few of the active methodologies are role play, quiz, brain storming, group discussion, implementing mini projects, industrial visit, in plant training, value added course(s), etc., An OBE system addresses the competency

requirement of students, and it organizes the curriculum and assessment methods to make sure this learning of OBE ultimately happens in young generation.

II. Overview of Criteria

NBA accreditation process has changed from output based method to outcome based as Tier-I and Tier-II accreditation processes. This new outcome based accreditation can be achieved through effective use of autonomy through vision, mission, goals, strategic planning of the institution. The following are the ten criteria specified by NBA for proving outcome based education in Tier-II Engineering program:

1. Vision, Mission and program educational objectives
2. Program curriculum and teaching-learning process
3. Course outcomes and program outcomes
4. Students' performance
5. Faculty information and contribution
6. Facilities and technical support
7. Continuous improvement
8. First year academics
9. Student support systems
10. Governance, institutional support and financial resources.

III. Levels of outcomes

There are four levels of outcome such as Course Outcome (CO), Program Outcome (PO), Program Specific Outcome (PSO) and Program Educational Objective (PEO) [4-5].

Course Outcomes are the statements that declare what students should be able to do at the end of a course. POs are defined by Accreditation Agencies of the country (NBA in India), which are the statements about the knowledge, skills and attitudes, graduate attributes of a formal engineering program should have [6]. Graduates Attributes (GAs) are the components indicative of the graduate's potential to acquire competence to practice at the appropriate level. GAs form a set of individually assessable outcomes of the programme [7]. The NBA laid down the graduate attributes relating to programme outcomes and is to be derived by program.

Program Specific Outcomes are the statements that assert what the grandaunts of a specific engineering program should do what they can able to do. Program Educational Objectives are the broad statements which describe in detail about the career and professional accomplishments after significant years of graduation that the program prepare the grandaunts to achieve.

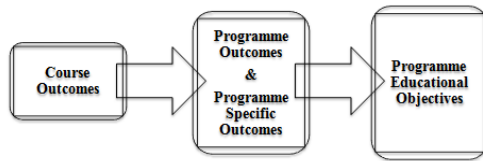


Figure 2: Relating the outcomes

Figure 2 shows the building block of CO-PO&PSO-PEO relationship. After CO statements are developed by the course in-charge, CO will map with any possible PO's based on the relationship exist between them. But the PO's are not necessarily mapped with any one CO and it may be left blank. Anyhow, it is mandatory that all POs should be mapped with any one of PSO and PEO which are specified in the program. This is shown in figure 3.

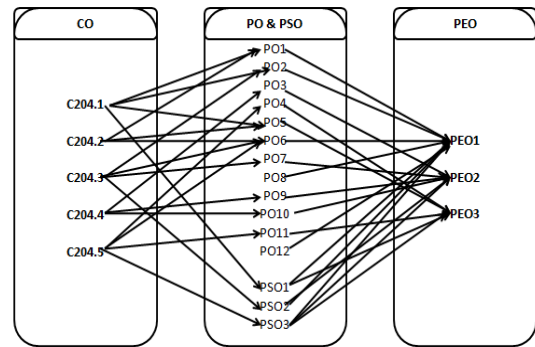


Figure 3: Relationship between CO, PO & PSO and PEO

IV. Process involved in CO-PO Mapping

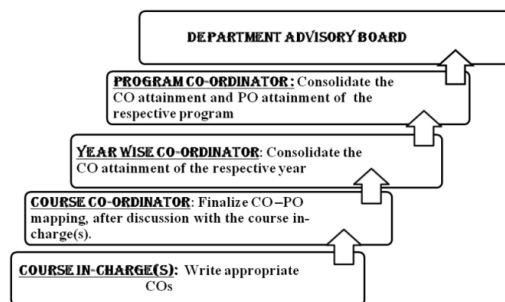


Figure 4: Hierarchy of faculty involvement

Kavitha et al [4] has been explained the hierarchy of faculty involvement in CO-PO mapping. The same technique is considered in this paper. The role of CO-PO mapping will be assigned to the faculty as per hierarchy followed in figure 4. After the course (subject) allotment from the department, the course in-charge of the course

has to write appropriate COs for their corresponding course. It should be narrower and measurable statements. By using the action verbs of learning levels, CO's will be designed. CO statements should describe what the students are expected to know and able to do at the end of each course, which are related to the skills, knowledge and behavior that students will acquire through the course. After writing the CO statements, CO will be mapped with PO of the department. If the department is having more than one section in a year or the same course is available for more than one program of the same institute in a semester, the subject expert will be nominated as course coordinator of the corresponding course. The role of the course coordinator is to review the CO statements and the CO-PO mapping which has been done by course in-charge. The year wise coordinator has to consolidate the CO's of the respective year and maintain the documentation of the CO attainment level of the respective year courses as well as documentation of the individual students' extra-curricular and co-curricular activities. These details will hand over to the program coordinator in order to evaluate PO attainment of the individual student as well as individual course at the end of the eighth semester. The Program coordinator has to evaluate the PO attainment of individual student through direct and indirect method after the student completing their program. All these works have to be done under the guidance of Department Advisory Board (DAB).

V. Mapping of CO with PO

First numeric digit indicates year of study and remaining two digits indicate course numbers in the respective year of study. C304 is the fourth course in third year. A sample course outcome statements and sample CO-PO matrix are given in Table 1 and 2 respectively.

Table 1: Sample CO statements

C304	Course Outcome Statement
C304.1	The students can be able to interpret the architecture and ALP of 8086 microprocessor based systems.
C304.2	The students can be able to analyze various bus structures of 8086 systems.
C304.3	The students can be able to interface various peripherals of 8086 micro processors and design various applications.
C304.4	The students can be able to infer the architecture and ALP of 8051 microcontroller based systems.
C304.5	The students can be able to interface various peripherals of 8051 and design various applications.

The CO-PO mapping has been done with correlation levels of 3, 2, 1 and '-'. The notation of 3, 2 and 1 denotes substantially (high), moderately (medium) and slightly (low). The meaning of '-' is no correlation between CO and PO.

Table 2: Sample CO-PO Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
C304.1	2	3	-	-	2	-	-	-	-	-	-	-
C304.2	3	-	-	-	2	1	-	-	-	-	-	-
C304.3	-	1	-	-	-	2	2	-	-	-	-	-
C304.4	-	-	3	-	-	-	-	-	2	1	-	-
C304.5	-	-	-	2	-	2	-	-	-	-	3	-
C304	2.50	2.00	3.00	2.00	2.00	1.67	2.00	-	2.00	1.00	3.00	-

Average value has to be taken for each CO. Average CO value is calculated by sum of value entered in each column is divided by number of CO mapped in each column (consider either 3, 2 or 1 entered and need not to consider ‘-’ entered).

Example: $C304-PO1 = (2+3)/2 = 2.5$

Each course outcome has been calculated from the topics which are assigned from each unit. To evaluate CO-PO matrix in micro-level calculation, Topic-wise, CO-PO mapping may be carried out. Table 3 shows the topic-wise CO-PO matrix for course outcome 4 of course C304.

Table 3: A sample Topic wise CO-PO Matrix

C304.4	TOPIC	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
C304.4.1	Architecture of 8051	-	-	3	-	-	-	-	-	-	-	-	-
C304.4.2	Special Function Registers	-	-	3	-	-	-	-	-	-	1	-	-
C304.4.3	I/O Pins Ports and Circuits	-	-	3	-	-	-	-	-	-	1	-	-
C304.4.4	Instruction set	-	-	-	-	-	-	-	-	2	1	-	-
C304.4.5	Addressing modes	-	-	-	-	-	-	-	-	2	-	-	-
C304.4.6	Assembly language programming	-	-	-	-	-	-	-	-	2	-	-	-
C304.4		-	-	3	-	-	-	-	-	2	1	-	-

Let us consider two or more faculty members are handling the same course, if there is any discrepancy in CO-PO mapping, course coordinator has to finalize CO-PO mapping with proper justification and a sample CO-PO justification correlation is given in Table 4.

Table 4: A sample for justification on CO-PO correlation

3: Substantial (High)	2: Moderate (Medium)	1: Slight (Low)
Provide training to do projects for any application using either hardware or software. (By giving mini projects, in plant training and industrial visit.	Motivate to collect information: Refer to the topic. (By giving case study and assignment).	Make unrealistic assumptions to develop model.

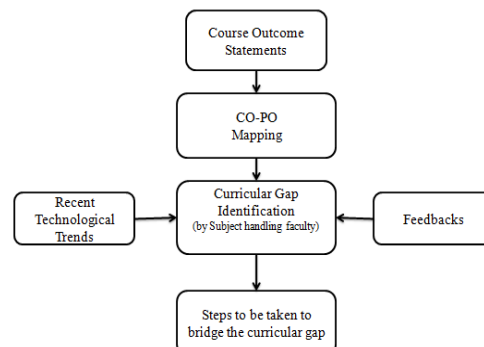


Figure 4: Identification of curricular gap

At the time of CO-PO mapping, the course in-charge has to identify the curricular gap in the course, based on the recent technological trends as well as feedback received from the stakeholders. After that, the course in-charge has to discuss with DAB about the steps to be taken to bridge the curricular gap as shown in figure 4. Content beyond the syllabus may be delivered to the students through teaching, arranging guest lectures, industrial visit, in plant training, online quiz, etc. Program level CO-PO matrix for all the courses including first year courses will be done by the program coordinator and a sample is given in figure 5.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
C101	2.00	1.00	0.00	1.00	1.00	3.00	2.00	0.00	3.00	1.00	1.00	2.00
C102	1.00	1.00	0.00	1.00	3.00	3.00	2.00	0.00	1.00	0.00	3.00	2.00
C303	0.00		1.00	1.00	1.00	1.00	0.00	2.00	0.00	1.00		3.00
C304	2.50	2.00	3.00	2.00	2.00	1.67	2.00		2.00	1.00	3.00	
C305	3.00	3.00	2.00	3.00		3.00	0.00	0.00	3.00	3.00	0.00	1.00
C312	3.00		0.00	3.00	2.00		0.00	2.00	2.00	0.00	1.00	3.00
C313	0.00	3.00	1.00	0.00	1.00	2.00	3.00	0.00	1.00	3.00	0.00	0.00
C411	1.00	1.00	1.00	3.00	3.00	0.00	3.00		3.00	3.00	0.00	2.00
C412	2.00	2.00	0.00	1.00	1.00	0.00	3.00	3.00	3.00	1.00	1.00	1.00
TARGET	1.27	1.33	1.52	1.49	1.34	1.70	1.50	1.31	1.40	1.42	1.38	1.37

Figure 5: Program level CO-PO matrix

VI.Validation of CO-PO mapping

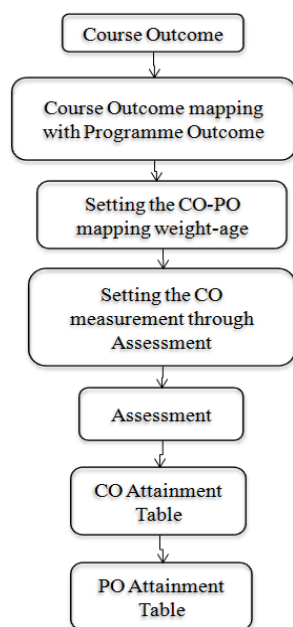


Figure 6: The process of CO-PO mapping validation

The process of CO-PO mapping validation [8] is given in figure 6 and is explained as below:

- Step 1 : Obtain course outcome.
 Step 2 : Mapping of course outcome with program outcome.
 Step 3 : Setting weightage for CO assessment.
 Step 4 : CO measurement through assessment.
 Step 5 : Obtain CO attainment table through direct and indirect assessment methods.
 Step 6 : Obtain PO attainment table through direct and indirect assessment methods.

VII.Assessment and Attainment methods

Assessment is one or more processes which is carried out by the institution, that identify, collect and prepare data to evaluate the achievement of course outcomes and program outcomes. Attainment is the action or fact of achieving a standard result towards accomplishment of desired goals. Primarily attainment is the standard of academic attainment as observed by test and/or examination result [6]. Assessment methods are categorized into two as direct method and indirect method to assess CO's and PO's. The direct methods display the student's knowledge and skills from their performance in the continuous internal assessment tests, semester examinations and supporting activities such as seminars, assignments, case study, group discussion, online quiz, mini project etc., These methods provide a

sampling of what students know and/or can do and provide strong evidence of student learning. The indirect method done through surveys and interviews, it asks the stakeholders to reflect their views on student's learning. The institute assess opinions or thoughts about graduate's knowledge or skills by different stakeholders [9].

Two types of CO assessment methods are employed in this paper and are given in case (i) and case (ii).

Case (i):

- Direct assessment method and indirect assessment method are considered for 80% and 20% weightages respectively.
- Internal test assessment and end semester examination assessment are considered with the weightage of 20% and 80% respectively for the direct assessment of CO.

Case (ii):

- Direct assessment method and indirect assessment method are considered for 80% and 20% weightages respectively.
- Internal test assessment, supporting activities and end semester examination assessment are considered with the weightage of 40%, 10% and 50% respectively for the direct assessment of CO.

As per NBA guidelines, program can appropriately define the attainment level. The attainment level may be set by the particular program or commonly by the institution. The attainment can be made as best the choice by the institution or the program by analyzing the students' knowledge. This can be achieved by using different supporting activities. This attainment is mainly for the purpose of making an esteemed engineer with good analytical, practical and theoretical knowledge about the program by attaining the PEO's and PSO's of the program and the institution. For the evaluation and assessment of CO's and PO's, rubrics are used [10]. The rubrics considered in this paper are given below:

Attainment Level 1: 50% of students score more than 50% marks out of the maximum relevant marks.
 Attainment Level 2: 60% of students score more than 50% marks out of the maximum relevant marks.
 Attainment Level 3: 70% of students score more than 60% marks out of the maximum relevant marks.

While setting the internal test question papers, cognitive objectives of Bloom's taxonomy is used for productive pedagogies. Bloom's taxonomy is a classification system of educational objectives based on the level of student's understanding for achievement. This technique is used to map question paper of university which is mapped to know the COs attainment of that course [11-12]. Course

exit survey from the student may be considered for the indirect assessment of CO with the weightage of 20%.

While calculating the PO attainment, we have to consider both direct assessment method and indirect assessment in the ratio of 80% and 20% respectively. CO attainment is considered as 80% weightage for the evaluation of direct attainment of PO.

The parameters such as co-curricular activities, extracurricular activities, alumni survey, grandaunt exit survey, employer feedback, exams such as GATE/IELTS/TANCET and other exam, etc., may be considered for the indirect assessment of PO with the weightage of 20% [6]. The example weightages for direct and indirect method used in this paper are reference only. Programs may have different weightages with appropriate justification [13].

VIII.CO-PO attainment

Case (i):

Figures 7, 8 and 9 show the CO attainment calculation through internal tests.

		Internal Assessment Test - 1																	
		Part-A (Marks 9x2=18)								Part-B (Marks 4x6=24)								Max = 50	Max = 50
COs-->		POs-->																	
COs-->		COs-->																	
S.No	Reg.No	Name	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q1	Q2	Q3	Q4	Total	>=50%		
1	1234567	Stud.Name-1	2	2	2	2	2	2	2	2	2	5	6	7	8	44	Y		
2	1234568	Stud.Name-2	1	1	1	1	1	1	1	1	1	2	3	4	5	23	N		
3	1234569	Stud.Name-3	0	0	0	0	0	1	2	1	1	5	6	7	8	31	Y		
4	1234570	Stud.Name-4	2	2	2	1	1	1	2	2	2	2	3	5	27	Y			
5	1234571	Stud.Name-5	0	0	0	0	0	1	2	1	1	2	3	4	5	19	N		
6	1234572	Stud.Name-6	1	0	0	1	2	2	2	1	4	4	3	5	25	Y			
7	1234573	Stud.Name-7	1	1	1	1	1	1	1	1	1	2	3	4	5	23	N		
8	1234574	Stud.Name-8	0	0	0	0	0	1	2	1	1	5	6	7	8	31	Y		
9	1234575	Stud.Name-9	2	2	2	1	1	1	2	2	2	5	6	7	8	41	Y		
10	1234576	Stud.Name-10	1	1	1	1	1	1	1	1	1	3	4	4	5	25	Y		
																	Y	7	
																	N	3	
																	NA	0	
																	CO-A	0.70	
																	Attainment Level	3	

Figure 7.Calculation of CO through internal assessment 1

		Internal Assessment Test - 2																Max = 26	Max = 26
		POs-->																	
		COs-->																	
S.No	Reg.No	Name	G1	G2	G3	G4	G5	G6	G7	G8	G9	G1	G2	G3	G4	Total	>=50%		
1	1234567	Stud.Name-1	2	2	1	2	3	2	2	3	5	6	7	8	17	Y	24	Y	24
2	1234568	Stud.Name-2	1	1	1	1	1	1	1	1	2	3	5	8	N	13	Y	13	Y
3	1234569	Stud.Name-3	2	2	2	0	1	2	1	1	1	4	5	11	N	14	Y	14	Y
4	1234570	Stud.Name-4	2	2	1	2	2	2	2	1	4	4	3	3	14	Y	15	Y	15
5	1234571	Stud.Name-5	2	1	1	1	1	1	1	1	3	6	7	8	15	Y	22	Y	22
6	1234572	Stud.Name-6	1	2	1	2	2	2	2	1	2	3	5	10	N	17	Y	17	Y
7	1234573	Stud.Name-7	2	1	1	1	1	1	1	1	2	3	4	5	9	N	14	Y	14
8	1234574	Stud.Name-8	2	2	2	2	0	1	2	1	1	4	4	3	3	16	Y	11	N
9	1234575	Stud.Name-9	2	2	2	1	1	1	2	2	2	3	4	5	12	Y	17	Y	17
10	1234576	Stud.Name-10	3	1	1	1	1	1	1	1	5	6	7	8	15	Y	20	Y	20
																		Y	6
																		N	1
																		NA	0
																		CO-A	0.60
																		Attainment Level	2

Figure 8.Calculation of CO through internal assessment 2

		Internal Assessment Test - 3																Max = 30	Max = 30
		POs-->																	
		COs-->																	
S.No	Reg.No	Name	G1	G2	G3	G4	G5	G6	G7	G8	G9	G1	G2	G3	G4	Total	>=50%		
1	1234567	Stud.Name-1	1	2	2	1	2	2	2	2	2	4	4	3	5	24	Y	23	Y
2	1234568	Stud.Name-2	1	1	1	1	1	1	1	1	1	2	3	4	5	13	Y	13	Y
3	1234569	Stud.Name-3	1	2	2	1	2	2	2	2	2	3	5	10	N	21	Y	21	Y
4	1234570	Stud.Name-4	1	1	1	1	1	1	1	1	1	2	3	4	5	8	N	14	Y
5	1234571	Stud.Name-5	2	2	2	2	2	2	2	2	2	7	7	7	7	22	Y	21	Y
6	1234572	Stud.Name-6	1	1	1	1	1	1	1	1	1	2	3	4	5	12	Y	12	Y
7	1234573	Stud.Name-7	1	1	1	1	1	1	1	1	1	2	3	4	5	13	Y	13	Y
8	1234574	Stud.Name-8	2	2	2	2	0	1	2	1	1	2	3	4	5	15	Y	14	Y
9	1234575	Stud.Name-9	1	2	2	1	2	2	2	2	2	4	4	3	3	14	Y	15	Y
10	1234576	Stud.Name-10	1	1	1	1	1	1	1	1	1	3	4	4	5	15	Y	20	Y
																		Y	7
																		N	3
																		NA	0
																		CO-A	0.70
																		Attainment Level	3

Figure 9.Calculation of CO through internal assessment 3

Figure 10 shows the CO attainment calculation through university examination.

			Overall Internal		University	
		POs-->	1,2,3,4,5,6,7,9,10,11		1,2,3,4,5,6,7,9,10,11	
		COs-->	CO1-5		CO1-5	
S.No	Reg.No	Name		CGPA		>=50%
1	1234567	Stud.Name-1	2.0	B		Y
2	1234568	Stud.Name-2	1.2	E		Y
3	1234569	Stud.Name-3	1.0	S		Y
4	1234570	Stud.Name-4	0.8	B		Y
5	1234571	Stud.Name-5	2.2	D		Y
6	1234572	Stud.Name-6	1.6	U		N
7	1234573	Stud.Name-7	0.4	A		Y
8	1234574	Stud.Name-8	1.2	C		Y
9	1234575	Stud.Name-9	1.6	C		Y
10	1234576	Stud.Name-10	2.2	D		Y
					Y	9
					N	1
					NA	0
					CO-A	0.90
					Attainment Level	3

Figure 10. Calculation of CO through university examination

Figure 11 shows the calculation of CO through direct assessment method.

		Individual Attainment Level										Overall Internal	Univ. Attainment Level	80% of Univ	20% of IA	Direct Attainment Level
		POs-->										1,2,3,4,5,6,7,9,10,11				
		COs-->										CO1-5				
S.No	Reg.No	Name	CO1	CO2	CO3	CO4	CO5	CO6	CO7	CO8	CO9	CGPA	>=50%	>=60%	>=70%	
1	1234567	Stud.Name-1	3.0	2.0	3.0	3.0	1.0	2.0	2.0	3.0	3.0	2.0	3	2.40	0.40	2.8
2	1234568	Stud.Name-2	0.0	0.0	1.0	2.0	3.0	3.0	3.0	3.0	3.0	1.2	1	0.80	0.24	1.0
3	1234569	Stud.Name-3	2.0	0.0	1.0	0.0	2.0	1.0	1.0	3	2.40	0.20	2.6			
4	1234570	Stud.Name-4	1.0	1.0	1.0	0.0	1.0	1.0	1.0	3	2.40	0.16	2.6			
5	1234571	Stud.Name-5	2.0	2.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	2.2	1	0.80	0.44	1.2
6	1234572	Stud.Name-6	1.0	2.0	2.0	2.0	3.0	3.0	3.0	3.0	3.0	1.6	0	0.00	0.32	0.8
7	1234573	Stud.Name-7	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.4	3	2.40	0.40	2.8
8	1234574	Stud.Name-8	2.0	2.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	2	1.60	0.92	1.8	
9	1234575	Stud.Name-9	3.0	1.0	2.0	1.0	1.0	1.0	1.0	1.0	1.0	1.6	2	1.60	0.32	1.9
10	1234576	Stud.Name-10	1.0	2.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	2.2	1	0.80	0.44	1.2

S.No	Reg.No	Name	POs--->	COs--->	Direct Attainment Level	Indirect Attainment Course Exit	Overall Attainment Level	Remarks
1	1234567	Stud.Name-1	2.8	2.1	2.3			Attained
2	1234568	Stud.Name-2	1.0	2.4	0.9			Not Attained
3	1234569	Stud.Name-3	2.6	2.6	2.1			Attained
4	1234570	Stud.Name-4	2.6	2.8	2.1			Attained
5	1234571	Stud.Name-5	1.2	1.9	1.0			Not Attained
6	1234572	Stud.Name-6	0.3	2.0	0.3			Not Attained
7	1234573	Stud.Name-7	2.5	1.8	2.0			Attained
8	1234574	Stud.Name-8	1.8	2.3	1.5			Attained
9	1234575	Stud.Name-9	1.9	2.4	1.6			Attained
10	1234576	Stud.Name-10	1.2	2.7	1.0			Not Attained

Figure 13. Calculation of CO through direct assessment
And indirect assessment

CO attainment calculation for the course C304 is shown in figure 14.

CO	IA-1	IA-2	IA-3	Average of corresponding CO
CO1	70%			70%
CO2		60%		60%
CO3		90%		90%
CO4			70%	70%
CO5			100%	100%
Average attainment				78%
Internal Attainment Value (3 for >70% (or) 2 for >60% (or) 1 for >=50% (or) 0 for				3
University Attainment Value (3 for >70% (or) 2 for >60% (or) 1 for >=50% (or) 0 for				3
Overall Direct CO Attainment (80% of University + 20% of IA)				2.4 + 0.6
Indirect CO Attainment				2.3
Overall CO Attainment (80% of Direct + 20% of Indirect)				2.4 + 0.46
				2.86

Figure 14. CO attainment calculation

CO-PO attainment of the course C304 is shown in figure 15.

$$\begin{aligned}
 3 &\rightarrow 2.86 \\
 2 &\rightarrow 2.86 \times (2/3) = 1.91 \\
 1 &\rightarrow 2.86 \times (1/3) = 0.95
 \end{aligned}$$

	P01	P02	P03	P04	P05	P06	P07	P08	P09	P010	P011	P012
C304.1	1.91	2.86			1.91							
C304.2	2.86				1.91	0.95						
C304.3		0.95			1.91	1.91						
C304.4			2.86						1.91	0.95		
C304.5				1.91		1.91					2.86	
C304	2.38	1.91	2.86	1.91	1.91	1.59	1.91		1.91	0.95	2.86	

Figure 15.CO-PO attainment of course C304.

Case (ii):

Figure 16 shows the CO attainment calculation through supporting activity.

S.No	Reg.No	Name	POs--->	COs--->	Supporting Activity	Attainment Status of SA
1	1234567	Stud.Name-1	2.5		2.5	Y
2	1234568	Stud.Name-2	2.8		2.8	Y
3	1234569	Stud.Name-3	2.6		2.6	Y
4	1234570	Stud.Name-4	2.9		2.9	Y
5	1234571	Stud.Name-5	2.7		2.7	Y
6	1234572	Stud.Name-6	2.7		2.7	Y
7	1234573	Stud.Name-7	2.6		2.6	Y
8	1234574	Stud.Name-8	2.5		2.5	Y
9	1234575	Stud.Name-9	3		3	Y
10	1234576	Stud.Name-10	2.9		2.9	Y
					Y	10
					N	0
					NA	0
					CO-A	1.00
					Attainment Level	3

Figure 16. Calculation of CO through supporting activity

Figure 17 shows the calculation of CO through direct assessment method.

S.No	Reg.No	Name	POs--->	COs--->	Supporting Activity 1,2,5,6,7	50% of Univ	40% of IA	10% of SA	Direct Attainment Level
					1,3				
1	1234567	Stud.Name-1	2.5		2.5	1.50	0.80	0.25	2.6
2	1234568	Stud.Name-2	2.8		2.8	0.50	0.24	0.28	1.0
3	1234569	Stud.Name-3	2.6		2.6	1.50	0.20	0.26	2.0
4	1234570	Stud.Name-4	2.9		2.9	1.50	0.16	0.29	2.0
5	1234571	Stud.Name-5	2.7		2.7	0.50	0.44	0.27	1.2
6	1234572	Stud.Name-6	2.7		2.7	0.00	0.32	0.27	0.6
7	1234573	Stud.Name-7	2.6		2.6	1.50	0.08	0.26	1.8
8	1234574	Stud.Name-8	2.5		2.5	1.00	0.24	0.25	1.5
9	1234575	Stud.Name-9	3		3	1.00	0.32	0.30	1.6
10	1234576	Stud.Name-10	2.9		2.9	0.50	0.44	0.29	1.2

Figure 17. Calculation of CO through Direct assessment

Figure 18 shows the calculation of CO through direct and indirect assessment methods.

S.No	Reg.No	Name	POs--->	COs--->	Supporting Activity 1,2,5,6,7	50% of Univ	40% of IA	10% of SA	Direct Attainment Level	Indirect Attainment Course Exit Survey	Overall Attainment Level	Remarks
					1,3							
1	1234567	Stud.Name-1	2.5		2.5	1.50	0.80	0.25	2.6	2.1	2.1	Attained
2	1234568	Stud.Name-2	2.8		2.8	0.50	0.24	0.28	1.0	2.4	0.9	Not Attained
3	1234569	Stud.Name-3	2.6		2.6	1.50	0.20	0.26	2.0	2.6	1.6	Attained
4	1234570	Stud.Name-4	2.9		2.9	1.50	0.16	0.29	2.0	2.8	1.6	Attained
5	1234571	Stud.Name-5	2.7		2.7	0.50	0.44	0.27	1.2	1.9	1.0	Not Attained
6	1234572	Stud.Name-6	2.7		2.7	0.00	0.32	0.27	0.6	2.0	0.5	Not Attained
7	1234573	Stud.Name-7	2.6		2.6	1.50	0.08	0.26	1.8	1.8	1.5	Attained
8	1234574	Stud.Name-8	2.5		2.5	1.00	0.24	0.25	1.5	2.3	1.2	Not Attained
9	1234575	Stud.Name-9	3		3	1.00	0.32	0.30	1.6	2.4	1.3	Not Attained
10	1234576	Stud.Name-10	2.9		2.9	0.50	0.44	0.29	1.2	2.7	1.0	Not Attained

Figure 18. Calculation of CO through Direct assessment
and Indirect assessment

Similarly CO can be measured for all the courses. The program outcomes are assessed with the help of course outcomes of the relevant courses through direct and indirect methods. PO attainment is to be obtained through direct and indirect methods and is shown in figure 19 and 20 respectively.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
C001	2.00	0.00	2.00	3.00	0.00	2.00	3.00	2.00	3.00	0.00	1.00	2.00
C001	2.50	2.00	2.00	1.00	2.00	2.50	1.50		3.00	1.00		
C002	3.00	3.00	1.00	3.00	3.00	0.00	2.00	0.00	1.00	1.00	2.00	2.00
C003	3.00		1.00	0.00	1.00	1.00	2.00	0.00	2.00	3.00		1.00
C004	2.42	1.89	2.90	1.94	1.94	1.62	1.94		1.94	0.97	2.90	
C005	1.00	2.00	0.00	1.00		0.00	3.00	2.00	1.00	0.00	0.00	1.00
C009	3.00	2.00		2.00		0.00	2.00	3.00	0.00	2.00	3.00	0.00
C411	3.00	3.00	2.00	2.00	1.00	1.00	3.00		1.00	3.00	3.00	0.00
C412	2.00	3.00	1.00	0.00	2.00	3.00	1.00	0.00	3.00	2.00	1.00	3.00
Direct PO Attainment	1.49	1.56	1.42	1.52	1.48	1.56	1.44	1.42	1.74	1.52	1.33	1.57

Figure 19. PO attainment through direct method

Indirect Assessment Tools	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Co curricular Activities		2	2	2	2	2	2	2	2	2	3	3
Extra-curricular activities			3			2	3	3	3	3	2	2
Graduate Exit Survey	2	3	2	2	2	2	3	1	1	2	2	1
Alumni Survey	2	2	2	2	2	3	2	2	2	2	2	1
GATE / IELT / TANCET & other exams	2											3
Indirect Attainment	2.00	2.33	2.25	2.00	2.25	2.25	2.50	2.00	2.00	2.00	2.40	1.75

Figure 20. PO attainment through indirect method

Figure 21 shows the PO attainment through direct and indirect method. Target value will be set to attain each PO. The target value for attainment of each PO deferred with each other. Before setting target value for PO, DAB should be consulted. A special action plan for the subsequent year may be designed and implemented to the PO's which didn't reach the target attainment values in the previous year [13].

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
C001	3.00	3.00	3.00	0.00	3.00	0.00	2.00	0.00	0.00	2.00	3.00	1.00
C001	2.50	2.00	2.00	1.00	2.00	2.50	1.50		3.00	1.00		
C002	3.00	3.00	2.00	3.00	0.00	2.00	2.00	3.00	2.00	1.00	0.00	2.00
C003	0.00	0.00	1.00	1.00	2.00	0.00	1.00	2.00	3.00	2.00	1.00	1.00
C004	2.42	1.89	2.90	1.94	1.94	1.62	1.94		1.94	0.97	2.90	
C005	2.00	1.00	2.00	0.00		2.00	3.00	3.00	2.00	2.00	0.00	1.00
C009	2.00	1.00		0.00		1.00	2.00	3.00	0.00	2.00	1.00	0.00
C411	2.00	2.00	3.00	0.00	1.00	2.00	3.00		2.00	1.00	2.00	0.00
C412	0.00	0.00	2.00	1.00	3.00	2.00	3.00	2.00	3.00	2.00	1.00	3.00
Direct PO Attainment	1.49	1.56	1.42	1.52	1.48	1.56	1.44	1.42	1.74	1.52	1.33	1.57
# Indirect PO Attainment	2.00	2.33	2.25	2.00	2.25	2.25	2.50	2.00	2.00	2.00	2.40	1.75
Overall PO Attainment (80% of Direct + 20% of Indirect)	1.59	1.71	1.58	1.61	1.63	1.70	1.65	1.53	1.79	1.61	1.55	1.61
# Target Set (Hypothesized values)	1.60	1.70	1.50	1.75	1.50	1.50	1.70	2.00	2.00	1.70	1.50	1.50
Remarks	Not Attained	Attained	Attained	Not Attained	Attained	Attained	Not Attained	Not Attained	Not Attained	Not Attained	Attained	Attained

Figure 21. PO attainment

The program specific outcomes are statements that describe what the grandaunts of a specific engineering program should be able to do. The PSO of the undergraduate program in engineering is obtained through the consideration of domain specific knowledge and technological development. A sample PSO is given below:

PSO 1: Electronic System Design Engineer:

- To demonstrate and analysis of electronic systems using new state-of-art in electronic circuits and communication.

PSO 2: Embedded and Communication Computing System Engineer:

- To design and develop models for progress on latest technological improvement in the fulfilment of embedded and communication system computing.

PSO 3: VLSI System Designer:

- Be expose into program developer/software programmer to chip level designer.

The program's educational objective is obtained by considering institute mission to produce grandaunts to sustain versatile professionalism. A sample PEO is given below:

PEO 1: Successful Careers:

- Grandaunts of Electronics and Communication department excel in professional career with sound problem solving ability for providing solutions by proper plan, analysis, design, implementation and validation.

PEO 2: Lifelong Learning:

- Grandaunts of Electronics and Communication department pursue training, advance study and research using scientific, technical and communication base to cope with the evolution in the technology.

The issues relating to PEO and PO may be related to varying assessment methods because of different understanding of course coordinators. According to Masni-Azian et al [13], there is no common ground of understanding with regard to determining the percentage of achievement. Sometimes, the course achievements may be determined by final exams or questions in the assessment or skill based assessment. We could not find a commonality on determining the percentage of achievement. CO-PSO mapping values are used to evaluate the attainment of PSO's which is not discussed this paper.

IX. Continuous evaluation

The assessment process in continuous evaluation may be done with the following steps:

- Step 1 : Data collection
- Step 2 : Data investigation.
- Step 3 : Result exploration.
- Step 4 : Required actions determination.
- Step 5 : Actions implementation.
- Step 6 : Impact of reason determination.
- Step 7 : Review process.

As per NBA guidelines, the continuous assessment is qualitative. Review process is the part of continuous evaluation. PO and PEO review assessment has to be done once in a year and improvements will be shown continuously during the delivery of course and assessment methods. PO and PEO will be reviewed in 3 to 5 years period and is based on assessment results in that period and changing needs of stakeholders.

By Doing continuous evaluation will bring the desired and expected improvements in teaching-learning process as well as assessment methods. Some of the teaching-learning process are content delivery such as identifying the prerequisite contents, conducting tutorials, making

more effort on selected areas, introducing simulations, doing lab exercises for the particular topic, implementing new teaching methodologies, etc., At the time of delivering the course, different methods may be introduced to make learning and teaching more effective and to obtain the desired course outcome attainment. Some of the improvements methods in assessment may be giving home assignments, case study, mini project, etc. Outcome based education system goes beyond the 'structured tasks'. It demands the students to demonstrate his/her skills through more challenging tasks like writing proposals and analyzing case studies that require more complex thoughts, which the traditional system of education failed over these decades.

X.CONCLUSION

Outcome-Based Education offers many steering thoughts, along with a dedication to learning for all students, possibilities for perfect assessment and interest in an integrated curriculum.

In this paper, detailed methods and various techniques of assessing CO and PO in an undergraduate engineering degree program are given. This paper provides an attainment method which is prepared in line with the guidelines indicated by NBA. The direct attainment is carried out for a particular course from internal and external exam results. The indirect attainment calculation is also carried out using various surveys. This analysis will help the faculty to plan new strategy for delivery, assessment and students involvement in learning for improvement in ensuing semester. In this way, OBE helps in identifying the gaps in the curriculum to meet the learning objectives to suit the industry requirements. The suggestions given in the continuous evaluation can be implemented for the same course in the subsequent academic year which will definitely provide the enhance level of PO attainments.

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