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A New Comprehensive Methodology for Evaluation of Course Outcomes and Programme Outcomes

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Abstract : Course Outcomes (CO) and Programme Outcomes (PO) are the backbone of Outcome Based Education (OBE) and their evaluation using a definite established methodology is necessary to track the progress and effective implementation of OBE. The CO, Course and PO attainment levels determine the extent to which the skill/abilities as envisaged vide POs are imbibed by the students. The CO, Course and PO attainment also provide an insight for corrective actions.

A new method for determination of CO, Course and PO attainment level is presented in this paper. The method is comprehensive and unique as it takes into consideration the varying weightage of each course component such as Continuous Evaluation (CE), Semester End Examination (SEE), and Laboratory and Practical Work (LPW). This not only ensures that all assessment components are covered but it also has a provision to take into account the effect of multiple mapping. This allows a teacher the flexibility to frame questions which can map with multiple COs. The proposed method gives individual as well as class attainment levels of the Course and the COs, thus allowing a more focused root cause analysis and corrective actions. The method also allows for calculation of the PO attainment level based on the CO and Course attainment level and the Program Articulation Matrix. The criteria for deciding the actions based on the PO and CO assessment levels are also presented.

Keywords: Accreditation; Course outcome; Direct attainment; Outcome based education; Program outcome

I. Introduction

Accreditation of the academic programmes serves a very important purpose of assuring stake holders about maintenance of quality in education. It is a validation of the quality initiatives taken and the teaching-learning process followed by an institute. It promotes a healthy competition amongst educational institutes, motivating them to strive for excellence in education. Implementation of OBE offers numerous advantages. It clearly defines the output expected from the teaching-learning process and systematically helps planning and implementation of curriculum delivery. The students are the largest beneficiary of OBE implementation as the focus changes from

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conventional approach of mere accumulating course credits to higher order learning and acquisition of cognitive thinking skills. Normally, a course comprises assessment components such as continuous evaluation, semester end examination and laboratory & practical work. Depending on the nature of the course, these components may have different weightage. Table I shows the typical weightage of various components for two courses of undergraduate (B.Tech.) programme. It is important to note here that the weightage of various course components is normally being decided by the course coordinator based on the nature of the course and course execution methodology planned.

Table 1 : Weightage Of Various Course Components

Course Component? Course ?	Continuous Evaluation (CE)	Semester End Examination (SEE)	Laboratory & Practical work (LPW)
ME301 Kinematics	0.6	0.4	-
ME601 Production Technology	0.4	0.4	0.2

Continuous evaluation refers to evaluation of students using various assessment tools on a continuous basis throughout the semester. The various assessment tools for continuous evaluation may be class test, course seminars, assignments, term paper, presentation, classroom interaction etc. The semester end examination is normally held at the end of the semester to assess the overall learning of the student. Laboratory and Practical Work refers to the continuous evaluation of exercises/activities carried out by the students in the laboratory for enhanced practical understanding of the course. The traditional methods of evaluating the CO based on the marks scored by students in SEE is highly myopic. First, it fails to highlight the extent of learning by the student throughout the semester as it is based only on examination normally held at the end of semester. Secondly, it does not take into consideration the nature of various courses.

The framework developed till this date by academic community has definitely reached a specific decisive state. It offers the advantages that it addresses both qualitative and quantitative methods. Another advantage is that the methods can be easily adopted by all teachers and are quick. The limitation being the qualitative and quantitative assessment is not being combined. Another limitation being, methods are rigid and offer no flexibility to the teacher in the execution considering variation in the course structure and nature of the course.

In the framework of OBE, all the courses have course outcome (COs). The COs are framed to fulfil the Program Outcomes (POs). In turn, POs are framed based on Program Educational Objectives (PEOs) and Mission & Vision of the institute. POs indicate the attributes that the graduates must possess in the broader sense whereas Program Specific Outcomes (PSO) indicate the graduate attributes specific to discipline of program. A great deal of coherency between the Mission & Vision, PEOs, POs, PSOs and COs is vital for effective implementation of OBE. COs and in turn courses are mapped with POs/PSOs. The Course Outcomes of a sample course (Kinematics), POs/PSOs, Course Articulation Matrix (mapping of POs/PSOs with COs and course) are shown in Table II, Table III and Table IV, respectively. The mapping of COs and courses with POs/PSOs is essential for evaluation of PO/PSO attainment level.

Table 2 : Course Outcomes of Subject Me301 – Kinematics

CO	Statement After successful completion of the course, student will be able to
ME301.1	understand the concept of machines, mechanisms and related terminologies.
ME301.2	analyse a planar mechanism for displacement, velocity and acceleration graphically.
ME301.3	analyse various motion transmission elements like gears, gear trains, cams, belt drive and rope drive
ME301.4	synthesise the planar mechanism for function generation and path generation.

Table 3 : Program Outcomes and Program Specific Outcomes

Program Outcomes 1. Engineering knowledge 2. Problem analysis 3. Design/development of solutions 4. Conduct investigations of complex problems 5. Modern tool usage 6. The engineer and society 7. Environment and sustainability 8. Ethics 9. Individual and team work 10. Communication 11. Project management and finance 12. Life-long learning
Program Specific Outcomes 1. Ability to apply the concepts of material science and engineering, computer aided engineering, thermal engineering and manufacturing technologies for design, development, analysis and maintenance of mechanical systems and processes. 2. Ability to work as a professional and/or as an entrepreneur by applying mechanical engineering principles and management practices.

Table 4 : Course Articulation Matrix (mapping Of Cos, Course With Pos/psos)

CO	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
ME301.1	Understand the concept of machines, mechanisms and related terminologies.	3													
ME301.2	Analyse a planar mechanism for displacement, velocity and acceleration graphically.		2											3	
ME301.3	Analyse various motion transmission elements like gears, gear trains, cams, belt drive and rope drive									1				3	
ME301.4	Synthesise the planar mechanism for function generation and path generation.				3									3	
ME301	Kinematics	3	2	-	3	-	-	-	-	1	-	-	-	3	-

*3,2 and 1 represent strong, moderate and marginal relationship respectively.

The PO/PSO attainment level is a direct measure of the extent of attainment of PEOs, and the accomplishment of Mission and Vision of the institute.

The Program Outcomes are predefined by the accreditation bodies like Accreditation Board for Engineering and Technology (ABET 2018), National Board of Accreditation, India (NBA 2018). Killan (2000) have outlined two kinds of outcomes of OBE. The first one is qualitative requiring learners to express their learnings and capabilities as an outcome of study of the program. The second type of outcome is quantitative comprising percentage course completion, employment, results of examination. The limitation of first approach is that it is based on the perception of the individual. The second approach is not dependent on the perception of evaluator but is not exhaustive and does not reflect the realistic attainment. Thus, both approaches do not represent the true picture of attainment. According to Brandt (1994) OBE consists of four principles viz. design down, expanded opportunities, focus and high expectations. A case study of assessment of PEO for an engineering programme is presented by Tshai et. al. (2014) wherein the level of attainment of PEOs is evaluated using surveys. The methodology of assessment based on exit surveys and exit test is proposed by Afida Ayub et.al. (2011)

Direct measurement of student learning and quantifying the same is a major challenge for institutions undergoing the process of accreditation. A simple method for CO attainment based on the marks obtained by students in various components such as final exam, test, quiz, assignment is developed by Izham Zind Abidin et.al. (2009). The same is extended by Hamimi Fadziati A Wahhab et.al (2011) for PO assessment.

The result of CO and PO attainment is a very important quality parameter of the study program. It reflects the immediate actions to be taken so as to ensure that all the necessary skills/qualities as promised by various COs are attained. Immediate actions may be organizing expert lectures, industrial visits, and specific assignments etc. Evaluation of the POs may result in long term actions to be taken such as changes in the curriculum, teaching methodologies, evaluation methodologies etc.

A new methodology for CO and PO evaluation is proposed in the work presented which is based on direct assessment and is comprehensive. The proposed methodology is based on following assumptions (i) The course comprises of one of many components such as Continuous Evaluation (CE), Semester End Examination (SEE), Laboratory and Project Work (LPW) and each component may have different weightage. (ii) The program coordinator conducts various surveys from various stake holders to decide the indirect attainment of POs. (iii) A courses and its COs map onto at least one PO. Similarly, at least one course / teaching exercise exists to address a PO. (iv) The course coordinator has specific plan to decide the corrective of actions based on results of CO attainment. The new method takes into consideration the fact that a question / assignment of an assessment tool may be mapped with multiple number of COs. Also the weightage of various components such as CE, SEE, LPW is taken into account while calculating the attainment level.

2. Methodology For Evaluation Of Co Attainment

The activities of teaching learning process are planned and executed in such a manner that all COs are being addressed. The faculty members should take utmost care such that all the COs are addressed during the teaching of the course.

The Course Outcomes of each courses are mapped with various questions of assessment components such as CE, SEE and with LPW. Considering the COs of the sample course (Kinematics) already listed in Table IV, mapping of COs (ME301.1 to ME301.4) with questions of assessment tools is shown in Table V. It is to be noted that in this case, the assignment is mapped with two COs i.e. ME301.1 and ME301.2, hence the value of multiple mapping for the assignment is 2. Similarly, LPW component is mapped with three COs; ME301.2, ME301.3, ME301.4 CO2 and CO3, hence the value of multiple mapping for LPW component will be 3. The remaining questions are mapped with only one CO therefore the value of the multiple mapping for these questions will be 1. Table V is only an illustration for demonstration purpose. The information in Table V is not used further in this paper.

Table 5 : Mapping of Various Questions of Assessment Components With The Cos.

CO	Semester End Exam (SEE)						Continuous Evaluation (CE)					LPW
							Class Test		Sessional Exam		Assignment	
	Q1	Q2	Q3	Q4	Q5	Q6	Q1	Q2	Q1	Q2		
ME301.1	√	√									√	
ME301.2			√	√				√			√	√
ME301.3					√		√					√
ME301.4						√			√	√		√

The determination of attainment level of CO1 for the sample course ME602 Machine Design, a course studied by UG Mechanical Engineering students is demonstrated here. The absolute marks obtained by 15 students in various components which are mapped with CO1 and attainment level of CO1 for the individual student as well as the entire class are shown in Table.VI.

The following points provide the gist of determination of individual CO attainment level for the individual student as well as for the entire class.

1) Total weighted marks and percentage weighted (PWM) marks obtained by student are calculated as

Table 6 : Marks Obtained By Students In Various Questions Of CO1

Component		Assignment (CE)	Semester End Examination (SEE)	Class Test (CE)	LPW (CE)	Sessional Exam (CE)	Total weighted Marks(TWM)	Percentage of weighted marks (PWM) obtained	CO Attainment level of Student
Weightage		0.4	0.4	0.4	0.2	0.4			
Question No		-	Q.1 A, B, Q.3 A, C	Q-1, Q-5		Q 1 B, Q 2 B,			
Multiple mapping		2	1	1	4	1			
Maximum Marks		30	22	8	100	16	29.4		
Sr. No	Column-> Student	C1	C2	C3	C4	C5	C6	C7	C8
1	Student 1	18	14.0	5	74	5	16.9	57	1
2	Student 2	23	17.0	4	87	6	19.8	67	2
3	Student 3	24	21.0	7	88	10	24.4	83	3
4	Student 4	20	12.0	6	66	6	16.9	57	1
5	Student 5	28	20.0	7	77	10	24.3	82	3
6	Student 6	18	17.0	7	66	9	20.1	68	2
7	Student 7	24	19.0	7	89	13	24.9	85	3
8	Student 8	24	12.5	5	75	4	17.2	58	1
9	Student 9	25	20.0	6	79	10	23.4	79	3
10	Student 10	20	14.0	5	64	6	17.2	59	1
11	Student 11	19	18.0	6	78	6	19.7	67	2
12	Student 12	19	13.0	5	63	5	16.2	55	1
13	Student 13	16	13.0	5	58	7	16.1	55	1
14	Student 14	21	18.0	6	72	7	20.2	69	2
15	Student 15	16	15.0	4	71	6	16.8	57	1
16	CO attainment level of entire class based on Average Percentage Weighted Marks)							67	2
Summary									
CO attainment level			3	2		1	0	>=2 (in %)	
No. of students			4	4		7	0	53.33 %	

$$Total\ weighted\ mark\ (TWM) = \sum \frac{Marks\ obtained\ in\ each\ compnent * corresponding\ weightag}{value\ of\ multiple\ mapping\ of\ the\ compnent}$$

$$Percentage\ Weighted\ Marks\ (PWM) = \frac{weighted\ marks\ obtained\ by\ the\ student * 100}{max\ weighted\ marks}$$

For Student 1, the calculation is as follows

$$TWM = \frac{18 * 0.4}{2} + \frac{14 * 0.4}{1} + \frac{5 * 0.4}{1} + \frac{74 * 0.2}{4} + \frac{5 * 0.4}{1} = 16.9$$

$$PWM = \frac{16.9 * 100}{29.4} = 57.48$$

2) The CO attainment Level of a particular CO of the student is determined based on the PWM scored by the student and the criteria for the same are mentioned in Table VII.

Table 7 : Criteria For Co Attainment Level of A Student For A Particular Co

Attainment level	3	2	1	0
Criteria	PWM >= 70%	70% >PWM >= 60%	60% >PWM >= 40%	PWM < 40%

Hence, the attainment level of CO1 for "student 1" is 1.

3) Attainment Level of CO for the entire class is calculated based on the Average percentage weightage marks (APWM) for the class. The APWM is calculated as

$$APWM = \frac{\sum PWM for\ all\ the\ students}{No\ of\ students},$$

The criteria for CO attainment level of the entire class is shown in Table VIII.

Table 8 : Criteria For Co Attainment Level of The Entire Class For a Particular Co

Attainment level	3	2	1	0
Criteria	APWM >= 70%	70% >APWM >= 60%	60% >APWM >= 40%	APWM < 40%

The CO attainment level of each student as reflected in the last column of Table VI facilitates the teacher to decide and implement corrective measures for each individual student and for the entire class. The CO1 attainment level for Student 1 is 1. CO1 for the course considered for demonstration Machine Design is "Students should be able to evaluate the fatigue life of machine components". The Student 1 can be asked to deal customized assignments such as (i) measuring frequency of fatigue cycles for the component---conducting R R Moore Test for the material of construction –evaluate the fatigue life of components. (ii) Development of fatigue test set up customized for the component and evaluating its fatigue life. (iii) conducting the non-destructive tests to measure the size of initial crack --evaluate final crack size and fatigue life.

The course ME601 consists of four COs. The methodology used for determination of attainment level of CO1 is also used for determination of attainment level of other COs. The summary of attainment level of all the 15 students of the class for all COs of the course is shown in Table IX, which

Table 9 : Summary Of Attainment Level of Cos and Course For Each Students And The Entire Class For The Subject Me601

Column->		C1	C2	C3	C4	C5
CO		CO1	CO2	CO3	CO4	Total
Sr. No	Maximum weighted Marks	29.4	38.2	18.6	13.8	100
	Student	Student wise CO attainment level				Student wise course attainment level
1	Student 1	1	2	1	2	1.52
2	Student 2	2	3	3	3	2.71
3	Student 3	3	3	3	3	3.00
4	Student 4	1	2	3	3	2.03
5	Student 5	3	3	3	3	3.00
6	Student 6	2	3	3	3	2.71
7	Student 7	3	3	3	2	2.86
8	Student 8	1	2	3	1	1.75
9	Student 9	3	3	3	3	3.00
10	Student 10	1	3	3	2	2.27
11	Student 11	2	3	3	3	2.71
12	Student 12	1	3	3	2	2.27
13	Student 13	1	3	3	1	2.14
14	Student 14	2	3	3	3	2.71
15	Student 15	1	3	3	3	2.41
16	Course attainment level of the Class					2.47
Percentage of students whose course attainment level >= 2						86.67

CO	CO1	CO2	CO3	CO4
CO attainment level of the Class	2	3	3	2
Percentage of students whose CO attainment level >= 2	53.33	100	93.33	86.67

facilitates the calculation of course attainment level for each student as well as for the entire class. Table VI reveals many aspects of teaching learning activities of the course.

The CO attainment level for the entire class as indicated in Sr. NO. 16 of Table VI is 1, the teacher may be required to take some corrective steps for the entire class. The nature of corrective measures can be (i) including more case studies of evaluation fatigue life (ii) organizing an expert lecture of industrial personnel involved in Residual Life Assessment of industrial machinery components. Similar exercise can be performed for the other courses.

The course attainment level for student and that for entire class is calculated as,

$$\text{Course Attainment Level for student} = \frac{\sum(\text{CO attainment level} * \text{Max weightage marks of CO}}{100}$$

$$\text{Course attainment level for the class} = \frac{\sum \text{course attainment level for all students}}{\text{No of students}}$$

To illustrate, the Course Attainment Level (CAL) for Student 1 is

$$CAL = \frac{1 * 29.4 + 2 * 38.2 + 1 * 18.6 + 2 * 13.8}{100} = 1.52$$

Table IX is the overall reflection of the attainment of the all course outcomes, course attainment for the individual student and for the entire class. As indicated in the Table IX, Student 1 has CO1 and CO3 attainment level 1 and also his / her Course Attainment Level is 1.52 (< 2). This indicated student centric measure to be implemented by the teacher. If the Course Attainment Level for the entire class as reflected by Sr. No 16 of Table IX is less than 2, instructor must make radical changes in teaching methodology, teaching contents, assignments, laboratory practices so that all the students of the class achieve the targeted course attainment level 2.

3. Methodology For Evaluation Of Pos And Psos

Attainment level of POs and PSOs is evaluated using two methods viz. Indirect method and Direct Method. Indirect method is based on the feedback of stake holders such as employers, alumni and also the participation by students in co-curricular and extra-curricular activities. The evaluation of POs and PSOs by indirect method is not discussed in this paper. The weightage for direct method is taken as 80% and that for indirect method is 20%.

The Program Articulation Matrix as shown in Table X is prepared for the program to be accredited. For demonstration, it is assumed that program comprises fifteen courses. Program Articulation Matrix shows the relationship (mapping strength) of course with POS/PSOs. A strong relationship of course with PO/PSO will be designated 3 (Substantial), moderate relationship designated by 2 and marginal relationship indicated by 1 (Slight). The program articulation matrix is prepared from the data of last row of course articulation matrix of each course. The last row of the course articulation matrix of each subject shows mapping strength of the course and the PO/PSO. The last row of the program articulation matrix shows the total weight of each PO/PSO and it is the sum of all mappings for a PO/PSO.

For Example, total weight for PO1 is 20 whereas that for PO2 is 14.

The CO and course attainment level of all the courses are evaluated for the given program and is summarized in Table XI.

Table 10 : Program Articulation Matrix

Course Name	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Subject 1	3	2		2	3		3			1		3	3	2
Subject 2	3	3		2		2	2						3	
Subject 3	3	2				3				2			3	
Subject 4	3		1		2		3	1	3	1			3	
Subject 5			2		3	2			3		2		2	
Subject 6	3	2	2		1	1			1					
Subject 7			2			3	2	3		3		2		
Subject 8		2					3		2		3	3		3
Subject 9	3	3		2	3				2				2	
Subject 10	2				2	2			2			2		
Total weights of each PO	20	14	7	6	14	13	13	4	13	7	5	10	16	5

Table X and Table XI facilitate the determination of attainment level of POs and PSOs. The next step is to evaluate the Course wise PO scores for all courses as indicated in Table XII by using the following formula:

$$\text{Course wise PO Score} = \text{Course Attainment Level} * \text{Mapping of Course with a PO}$$

Table 11 : Summary Of Co And Course Attainment Level For The Class For All Courses

Course Name	CO 1	CO2	CO3	CO4	CO5	Course attainment level
Subject 1	2	3	3	2		2.47
Subject 2	3	2	2	1	2	1.97
Subject 3	3	3	3	2		2.45
Subject 4	2	2	2	3		2.21
Subject 5	2	2	3	3		2.26
Subject 6	2	3	1			1.80
Subject 7	2	2	2	2		2.18
Subject 8	2	2	2			2.22
Subject 9	3	3	3	3		2.62
Subject 10	2	2	3	2		2.29

For example, the PO Score for the Subject 1 of PO1 is 2.47 X 3 = 7.41. Where '2.47' is the course attainment level of Subject 1 as indicated in last column of Table XI corresponding to Subject 1 and '3' is the course mapping strength (strongly mapped) of Subject 1 with PO1 indicated in Table X. Similarly, for each PO/PSO, PO score is calculated for all the subjects.

The Direct Attainment Level of a PO is evaluated as

$$PO\ Attainment\ level = Total\ PO\ score\ of\ a\ PO / Total\ weight\ of\ the\ PO$$

Where total PO score of each PO/PSO is the summation of course wise PO score of each PO/PSO. The possible range of the attainment level of any PO/PSO will be between 0 to 3. Assuming that the indirect attainment level of the PO/PSO are provided as mentioned Table 13.

Table 12 : Course Wise Po Score For All Courses Of The Program

Course Name	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Subject 1	7.41	4.94	0.00	4.94	7.41	0.00	7.41	0.00	0.00	2.47	0.00	7.41	7.41	4.94
Subject 2	5.91	5.91	0.00	3.94	0.00	3.94	3.94	0.00	0.00	0.00	0.00	0.00	5.91	0.00
Subject 3	7.35	4.90	0.00	0.00	0.00	7.35	0.00	0.00	0.00	4.90	0.00	0.00	7.35	0.00
Subject 4	6.63	0.00	2.21	0.00	4.42	0.00	6.63	2.21	6.63	2.21	0.00	0.00	6.63	0.00
Subject 5	0.00	0.00	4.52	0.00	6.78	4.52	0.00	0.00	6.78	0.00	4.52	0.00	4.52	0.00
Subject 6	5.40	3.60	3.60	0.00	1.80	1.80	0.00	0.00	1.80	0.00	0.00	0.00	0.00	0.00
Subject 7	0.00	0.00	4.36	0.00	0.00	6.54	4.36	6.54	0.00	6.54	0.00	4.36	0.00	0.00
Subject 8	0.00	4.44	0.00	0.00	0.00	0.00	6.66	0.00	4.44	0.00	6.66	6.66	0.00	6.66
Subject 9	7.86	7.86	0.00	5.24	7.86	0.00	0.00	0.00	5.24	0.00	0.00	0.00	5.24	0.00
Subject 10	4.58	0.00	0.00	0.00	4.58	4.58	0.00	0.00	4.58	0.00	0.00	4.58	0.00	0.00
Total PO Scores of each PO	45.14	31.65	14.69	14.12	32.85	28.73	29.00	8.75	29.47	16.12	11.18	23.01	37.06	11.60
Total weights of each PO	20	14	7	6	14	13	13	4	13	7	5	10	16	5
Direct PO attainment level	2.26	2.26	2.10	2.35	2.35	2.21	2.23	2.19	2.27	2.30	2.24	2.30	2.32	2.32

Table 13 : Indirect Attainment Level of Po of The Program

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
Indirect attainment level	2.29	2.07	2.19	2.07	2.15	1.99	2.05	2.16	2.36	2.12	2.07	2.06	2.07

Therefore, the final PO attainment level of the program will be calculated by considering 80 percentage weighted of direct attainment level and 20 percentage weightage of indirect attainment level. Indirect attainment is based on various surveys such as exit surveys, employer surveys, co-curricular activities, industrial visit feedbacks etc. As indirect attainment is based on perception of the individual, its weightage is taken is 20 % in the evaluation of POs. The final PO attainment level of the program is shown in Table XIV.

Table 13 : Final Attainment Level of Pos/psos of The Program

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Direct attainment level (80% weightage)	2.26	2.26	2.10	2.35	2.35	2.21	2.23	2.19	2.27	2.30	2.24	2.30	2.32	2.32
Indirect attainment level (20% weightage)	2.29	2.07	2.19	2.07	2.15	1.99	2.05	2.16	2.36	2.12	2.07	2.26	2.06	2.07
Final Attainment level	2.26	2.22	2.12	2.30	2.31	2.17	2.19	2.18	2.29	2.27	2.20	2.29	2.27	2.27

To maintain the quality of the teaching learning process, the percentage of students in the class who have achieved the target level and above of attainment level of course and CO is also calculated for taking the corrective action if it is below the said target. In this study the target of Course and CO attainment level is taken as 2. Table XV shows the summary of percentage of students whose attainment level is 2 and above (course wise and CO wise).

Table 15 : Percentage of Students Whose Attainment Level is 2 And Above Course And Co Attainment.

Course Name	CO1	CO2	CO3	CO4	CO5	Course
Subject 1	53.3	100.0	93.3	86.7		86.67
Subject 2	86.4	81.6	47.2	45.6	68.0	46.40
Subject 3	87.2	81.6	98.4	61.6		76.00
Subject 4	72.8	79.2	80.8	100.0		65.60
Subject 5	71.0	44.4	100.0	100.0		70.20
Subject 6	56.1	75.7	44.6			38.40
Subject 7	88.9	88.9	88.9	88.9		80.95
Subject 8	83.2	73.6	86.4			68.00
Subject 9	100.0	83.1	81.8	100.0		87.80
Subject 10	77.7	68.9	97.3	76.4		71.60

4. Criterions For Deciding Actions Based On Co And Po Evaluation

The CO, course and PO attainment levels form the basis for actions to be taken. These actions are essential to ensure that the students possess required skills/abilities as promised by POs and PSOs. The Figure 1 illustrates the methodology for identifying the course and the course outcomes which lack the attainment and require some action based on the nature of CO. Figure 1 is drawn considering the target value of PO, PSO, course and CO attainment level as 2 and the target value of percentage of students whose course and CO attainment level is 2 and above is 60%.

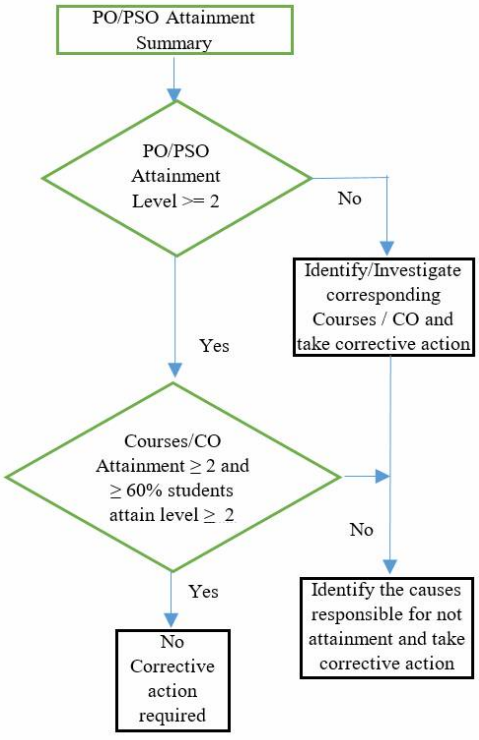

Fig. 1: Flow chart indicating criterions for actions to be taken based on CO & PO Attainment levels.

Many at times it is observed that all POs are attained vide their mapping with the courses. Hence, PO attainment level should be greater than its target value and this is necessary but not sufficient condition for ensuring effective implementation of OBE. In the event that PO attainment level of all POs/PSOs is greater than the target value, then attainment level of COs/Courses is checked and the corrective actions are to be taken if attainment level of the COs/Courses is below the target value.

5. Conclusions

The paper throws light on a new methodology for evaluation of attainment level of CO, courses and PO / PSO for effective implementation of OBE. The method proposed is unique and comprehensive as

- It takes into account the weightage of various components of the course.
- There exists a provision for multiple mapping of assessment component with COs.
- The CO attainment level for each student and for the entire class can be estimated giving ample scope for multiple possibilities of corrective actions.
- Methodology is also presented for corrective actions based on CO, Course, PO and PSO attainment levels.

At each stage during the evaluation, the methodology facilitates the instructor to adopt student centric / class centric remedial measures or corrective actions based on the attainment levels of CO, Course and the POs / PSOs. It is expected that adoption of this method will simplify the efforts of engineering institutions for accreditation and also help them introspect the teaching learning practices.

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