

Direct Program Outcome Assessment Tool for Creation of Student Portfolios in OBE Framework

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Abstract - This paper aims at demonstrating tool for assessing Program outcomes at student level, identifying strengths of individual and mapping with potential pathways of student career progression. Outcome based education (OBE) is prevalent throughout the world changing the dynamics in teaching learning process. The challenges in outcome based education are existing in all stages from planning to implementation. One such important element in OBE which is always challenging is to determine the attainment of course outcomes and program outcomes. The existing traditional system measures only outcome from the course but analysis at student level is lacking. The objective of this study is to compare two CO assessment tools bringing out merits and demerits of each tool at course level. One tool averages the attainment for each question and other tool determines student level outcomes. The student level outcome method offers a promising tool in developing student portfolios which in turn can be useful in grouping the students based on their strengths and weaknesses for their holistic development.

Keywords: *dynamics, holistic development, student portfolios, Outcome based education*

INTRODUCTION

Outcome based education is becoming mandate and requirement of education in India in most of the engineering degree offering institutes to improve the quality of graduates in engineering program. There is a shift in focus from traditional oriented approach to output oriented approach which involves determination of very detailed and rigorous assessments of student outcomes. The quality of teaching is not measured in terms of quality of learning. The expected outcomes from the graduating engineer relate to the holistic development characterized in terms of knowledge, skill and attitude. This calls for a scientific development of an OBE framework for every institute that will design the entire teaching learning process in education to meet the set goals. OBE framework is channelized in orienting the education system towards predefined student outcomes at the end of each course and finally at the end of the program. Every institute has its own OBE model typically developed by IQAC (Internal Quality Assurance Cell) in the institute. OBE model starts with defining the vision and mission statements at the institute level followed by vision and mission statements at the program level. Program educational objectives are also defined with an input from the stakeholders. Twelve Program outcomes have been generalized by National Board of accreditation (NBA) that are common to any engineering graduates. Program Specific outcomes are defined at the program level that are specific to the program based on the facilities and expertise available in the department. The curriculum is designed in line with PO's (Program Outcomes) and PSO's (Program Specific Outcomes) with an input from external and internal stakeholders. Each course in the curriculum has course outcomes mapped with the relevant PO and PSO. The courses are delivered with various teaching – learning strategies to achieve the Course outcomes (CO's). Assessment and Evaluation are done at program level and at course level through direct and indirect methods. Direct methods at course level include continuous internal assessments and semester end examinations. Indirect methods at course level include collecting the course end survey from the student to determine how far the course outcomes are achieved. The course outcomes thus assessed from the direct and indirect assessment tools are used to determine PO attainments through the mappings of the course. However there are also indirect assessment tools of the PO obtained from stakeholders surveys like Alumni survey, Employer survey, Program exit survey and student portfolios. The assessment of program outcomes forms the basis for identifying the gaps and develop actions for quality improvement of student outcomes. This is a continuous cycle and the process of outcome based education will make iterations to improve the quality of students. The continuous quality improvements involves lot of planning, data collection, analysis, reporting and implementation. Various tools are available in the literature to determine CO's and POs directly and indirectly. In the direct assessment of CO's, when the assessment is made from internal examination and semester end examination, the examination questions are framed to address the COs of the course and POs of the program. The question wise marks are obtained and each question is mapped to the CO. There could be various methods to arrive at the attainment of each CO from the marks scored by the student in each question. This study compares two such methods of direct attainment of CO's. The OBE framework is given in figure 1.

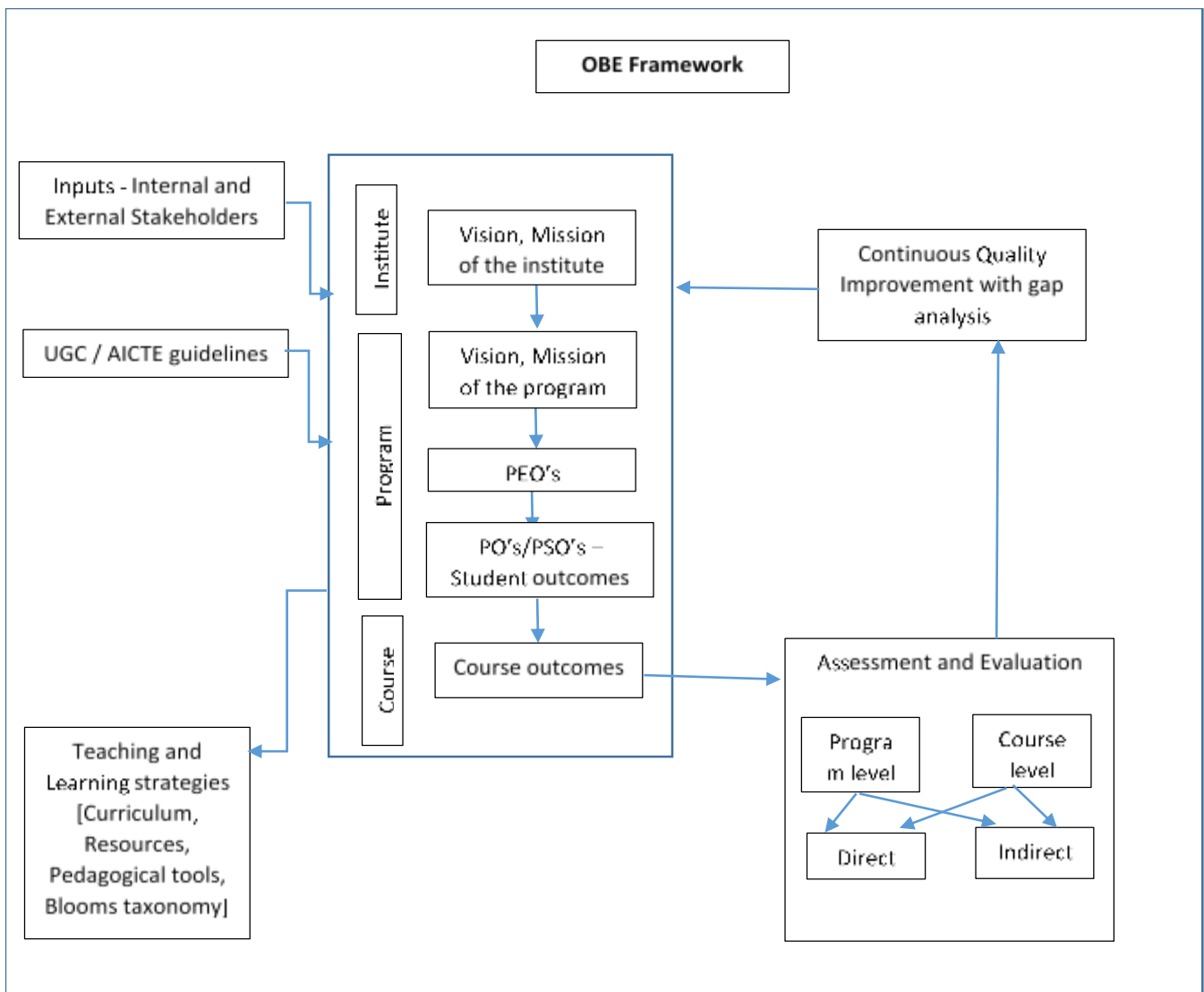


Figure 1. OBE framework

LITERATURE REVIEW

Tools for CO attainment could be both direct and indirect (G Kulkarni & Barot, 2019) (Magan More, Welka, P.S, Kolhe, C. D., & P. G, 2016). Direct attainment comprise of tools such as internal exam, semester end exam, assignments, quizzes etc. while Indirect attainment tools could be course end survey, viva-voce, model making etc. Substantially higher weighs are defined for direct in relative to indirect segment by a program level committee. These weighs could be defined both at program level evenly for all courses or at course level based on activities involved and nature of the course. In general a common proportion of direct and indirect tools are prescribed unless institute has significant experience in OBE frame work. Over past decade most commonly only direct tools were used in determining CO attainments (Jeyanthi, 2019) (Ramchandra, Maitra, & Babu, 2014) (Rawat & Karkare, 2015) but by considering indirect tools one can obtain more comprehensive attainment of student's performance. Keeping ever growing workload of teachers (Magan More, Welka, P.S, Kolhe, C. D., & P. G, 2016) devised overly simplified indirect approach to circumvent tedious processes involved and claims to have improved attainments by following newly devised indirect approach, but it is to be noted that different methodologies are based on different grounds of stands hence they cannot be compared. The comparison is only possible between attained and set values defined on similar grounds. This doesn't mean that research for alternate or new assessment methodologies should stop. The quest of finding out most comprehensive and simplistic approach should drive further research on this front. Further to broad weighs define to direct and indirect tools, weighs are further defined to each tool used in assessment based on relative importance as defined in scheme of instruction. A two stage transformation process was adopted by (Gamboaa, Namasivayamb, Al-Atabic, & Singhd, 2013) (G Kulkarni & Barot, 2019) (Rawat & Karkare, 2015) to calculate final attainments. Not all the institutes have luxury to obtain question wise marks scored by each student in an external exam as the evaluation could have been done centrally at affiliated university this brought the need of transforming total marks scored. One stage to proportionate marks scored under various exam tools and the second is to convert total marks to marks attributed to certain CO. Such normalised scores are compared against normalised targets to access attainment status CO-wise. It has been a practice to calculate cohort attainments for accreditation process to have broad assessment of the whole batch of students. While a few (Gamboaa, Namasivayamb, Al-Atabic, & Singhd, 2013) demonstrated student level attainments to have micro level understanding of attainments. This paper explores application of such deep down

analysis for continuous improvement of student attainments amongst the proposed graduate attributes Pos and PSOs within the duration of study.

The levels of attainment are generally defined based on percentage of student population achieving a set threshold administered by Program level board or course coordinator (Dr.A.Kavitha, K.Immanuvel, K.A.Harish, & Dr.V.Rajamani, 2017). Threshold values should ideally be a statistical output of performance by past batches. Thresholds can be fixed at course level or at program level. It has been a common practise among institutions that adopted outcome based education in recent times to administer a common threshold to all courses of program thereby common definition of levels of attainment (Jeyanthi, 2019) (Banala, Mishrab, & Sachdevac, 2021) primarily to monitor attainments effortlessly. Some institutes establish pass mark as threshold (Rawat & Karkare, 2015). Collation and comprehension of such stats for each course is considered tedious without any ERP system in place while teachers are already overloaded with several academic and administrative activities. Few institutions (Gamboaa, Namasivayamb, Al-Atabic, & Singhd, 2013) had devised customised spread sheets to calculate CO attainments, while other's saved huge man hours by administering ERP packages (Inpods, 2020) exclusively designed to calculate CO,PO and PSO attainments of all the courses and program respectively. In general institutions with less experience may start considering pass mark as threshold until they find firm foot in using OBE framework. As institute gains experience, based on previous performance of at least 3 batches the program level board may recommend attainment levels based on threshold and percentage of student populations exceeding it. With time the thresholds or percentage of student population can be increased to set higher standards while it is also possible to have both parameters dynamic to continuously improve standards (Banala, Mishrab, & Sachdevac, 2021). Some have defined cohort attainments relative to maximum marks instead of defining population exceeding set threshold (Magan More, Welka, P.S, Kolhe, C. D., & P. G, 2016) (Gamboaa, Namasivayamb, Al-Atabic, & Singhd, 2013). Some have established mean of students' performance of past three batches to level 2, while within standard deviation on lower side of the mean is defined as level 1 and the one higher side of mean is defined as level 3 of attainments.

Earlier practices of OBE (Jeyanthi, 2019) have considered overall marks scored by students to understand attainment at course level which thereby ignored question wise mapping to respective COs and establishing CO-wise attainments. Even though question scores are available some still resorted to simple average of all attainments hence cannot provide micro level understanding at CO level thereby loosing possibility of taking specific action for improvement. Question wise CO mapping is necessary to perform CO-wise analysis. It is not a good practice to take simple average of attainments obtained from different questions classified under same CO without giving due weigh for maximum marks of each question (Dandin, Jinde, & Kamble, 2018) (Ramchandra, Maitra, & Babu, 2014). Some have summed up scores obtained in different questions classified under different heads and compared against threshold to define level of attainment. This approach definitely seems to be better alternative to simple average but it obscures the possibility of understanding attainment at concept level corresponding to the question thereby disabling the opportunity of devising action plan at topic/concept level. As discussed earlier when question wise marks are not available the total marks are diffused using conversion quotients devised according to the distribution of marks over various Cos as per the scheme of valuation. Though there couldn't be other way, the inherent assumption here is the scoring pattern of all students under various CO heads is same as the distribution in scheme of valuation. While it should be further understood that scoring patterns of every student could be unique to the individual hence such approach is not recommended for student level attainments.

OBJECTIVES OF THE STUDY

Following are the objectives framed in the study.

1. To recommend direct CO attainment tool for OBE framework
2. To compare student wise attainment framework and question wise attainment framework

METHODOLOGY

After the careful design of scheme of instructions envisaging successful attainment of graduate attributes, Program Outcomes (PO), Program Specific Outcomes (PSO). For each course part of scheme Course outcomes (CO) are defined. CO statements are broader learning attributes of the course which are measurable and realistic in character. In most of the cases COs are defined by the course instructor while in case the same course is been offered to multiple classes by different instructors a course coordinator will finalize the CO statements. Also, the relationship between CO statements and POs & PSOs are established in an articulation matrix, CO-PO mapping. Total attainment of PO is arrived using various direct and indirect tools. PO direct attainments are arrived using CO attainments and the articulation matrix. CO attainments are determined based on student population performance in the well-designed assessments. The PO attainment framework is shown in figure 2.

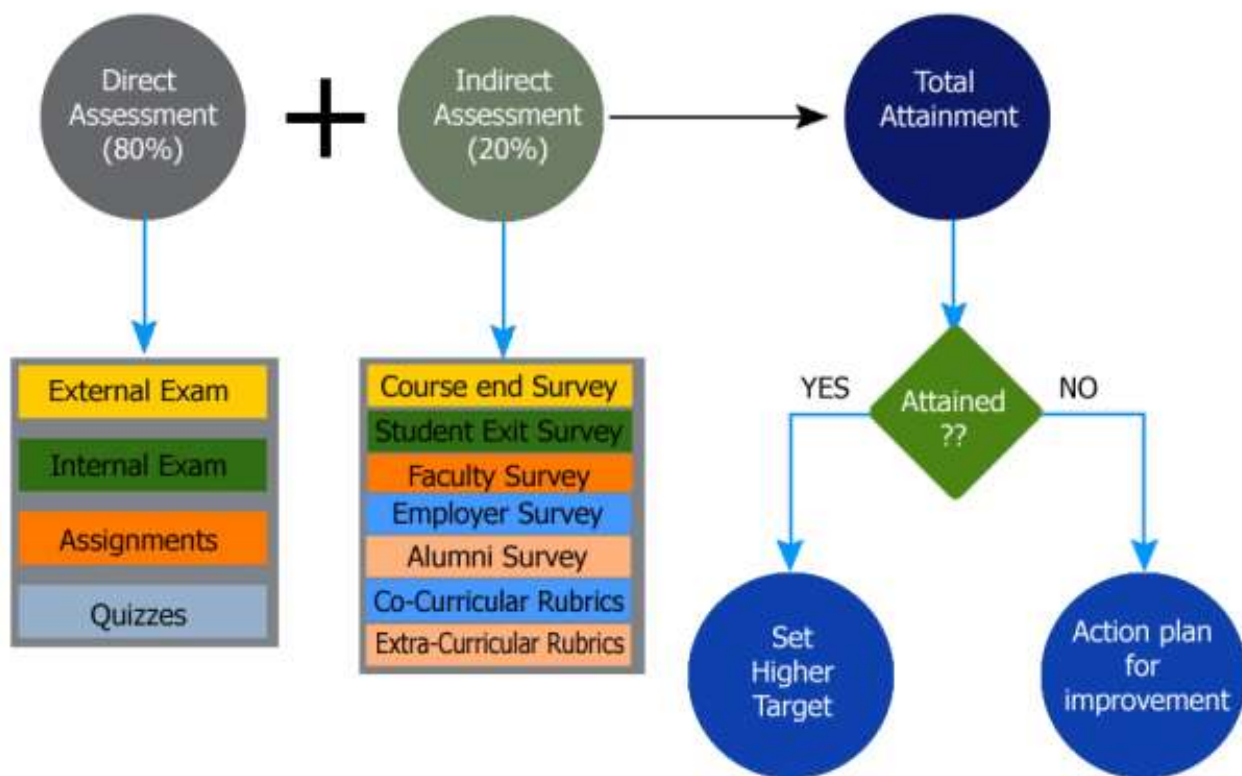


Figure 2. PO Attainment framework

This section will illustrate attainment of CO's using two different approaches and will present a contrast in them. The former approach is named as student wise attainment (SWA) and the second as cohort's attainment (COHA). The CO attainment process is shown in figure 3.

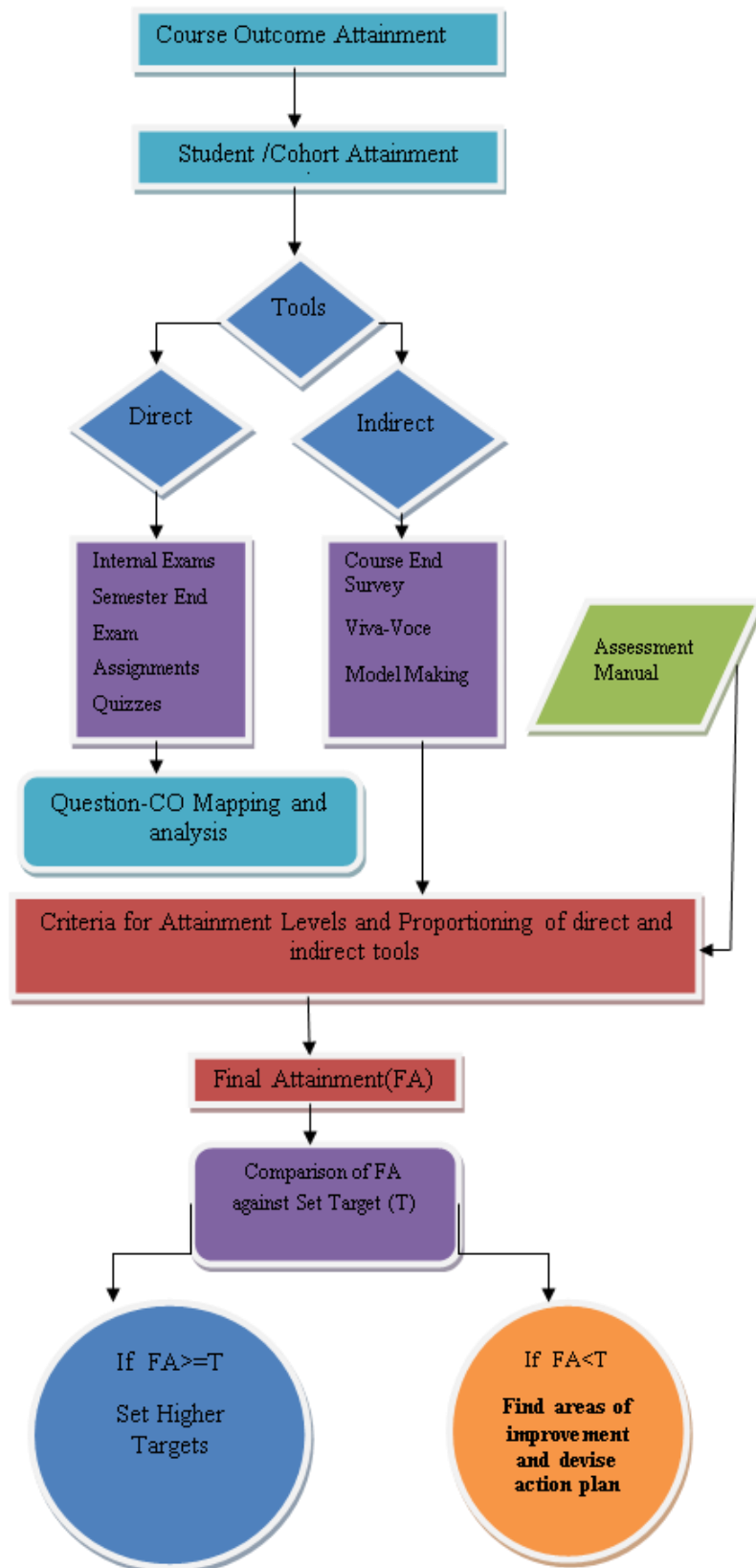


Figure 3. CO Attainment framework

Total CO attainment is generally obtained out of Continuous internal assessment (CIA) tests and Semester End Examination (SEE). Even though valid procedure is to proportionate attainments obtained out of various assessments and a summation of them is obtained as Total attainment of CO. This paper considers only one assessment tool to demonstrate CO attainments.

A. Defining the course outcomes

Course outcomes are defined for each course in line with Program outcomes which the students are expected to accomplish at the end of the course. They are typically 4 to 6 in number and are statements starting with action verbs of Blooms taxonomy. The course outcomes have three components / characteristics – Performance, Criteria and Condition. The Performance component is a

description of the behavior that learners are expected to perform. It should be measurable and observable. It describes what the learner will be doing when demonstrating mastery of an objective. The Conditions component of an objective is a description of the circumstances under which the performance will be carried out. It also includes a description of the special items (equipment, facilities, etc.) will be available to learners when they perform the desired behavior. The criterion is a way to measure an acceptable or adequate performance. Stating the criterion lets learners know how well they will have to perform to be considered competent. In addition, it provides a standard against which to test the success of the instruction, and gives you a way of evaluating whether or not the learners can, in fact, do what you set out to teach them. The course outcomes defined for a course in Civil engineering are given in table 1 below.

Table 1. Course outcomes for Soil Mechanics

CO no	Course outcome	Blooms taxonomy
1	Classify and identify various types of soils.	Understanding
2	Understand the concepts of permeability, effective stress and seepage in soils	Understanding
3	Analyse the compaction effect and consolidation settlements in soils	Analyzing
4	Determine shear strength of soils.	Evaluating
5	Evaluate earth pressure and analyze stability of slopes.	Evaluating

B. CO – PO mapping

All COs for a course must be mapped with PO in such a way that they contribute to the attainment of POs. The mapping is done at three levels as Low (level 1), Moderate (level 2), and Substantial (level 3) based on its contribution to the PO and number of hours allocated to a particular course outcome. Faculty prepares a justification report for the mapping given. The CO –PO mapping for a course is given in table 2 below.

Table 2. CO – PO mapping for Soil Mechanics course

CO no	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3											
2	3											
3	3	3										
4		3										
5		2	1				1					

C. Development of assessment tools for direct assessment and indirect assessment of the course outcomes

The direct assessment tools for a theory exam include Continuous Internal Assessment (CIA) and Semester End Examination (SEE). Continuous internal assessment is done through two internal examinations, assignments and quizzes. Separate rubrics could be used for evaluating the assignments and determining course outcomes. The internal examination may cover two or more course outcomes depending on the course outcome coverage. But it is mandatory that all the course outcome attainments are made in the direct assessment tools. Indirect assessment of course outcomes can be done through course end exit survey taking feedback from the students on how the course outcomes were accomplished during the teaching learning process. Assessment tools for course outcome attainment through direct assessment for a sample course in Civil engineering is shown in table 3.

Table 3. Assessment tools for course outcome attainment through direct assessment for a sample course

Type of assessment	CO1	CO2	CO3	CO4	CO5
I internal examination	√	√	√		
II internal examination			√	√	√
Assignment 1	√				
Assignment 2			√	√	
Assignment 3		√			√
Quiz 1	√	√			
Quiz 2			√	√	
Quiz 3					√
Mini Project				√	√
Semester end examination	√	√	√	√	√

D. Determination of weightage of assessment tools in determination of CO attainment

The weightage of assessment tools is determined for final CO attainment at the start of the course. The weightage is decided by the faculty based on the CO coverage or it can be generalized at the institute level by IQAC. In the present study, it has been decided by the faculty based on weightage of marks assigned to the assessment tool. However, the weightage can be given even though marks are not allotted to the assessment tool. The table below shows the weightage of the assessment tools for a sample course

Table 4. Weightage of direct assessment tools

Type of assessment	Weightage
Internal examination	30%
Assignments	5%
Quizzes	5%
Semester end examination	60%

The indirect assessment weightage is also decided and the final CO attainment considers both direct and indirect assessment based on their weightage. The distribution of direct and indirect assessment tools considered in the present study is given in table 5.

Table 5. Direct and Indirect assessment weightage

Assessment type	Weightage
Direct	80%
Indirect	20%

E. Setting the course attainment target

The faculty sets the course attainment target for the course he is handling. The target is set for individual course outcome based on the average of previous years attainments or with any other method available or specified by IQAC. The targets are specified in terms of thresholds.

F. Setting the question paper

The question paper must be set following the Blooms taxonomy covering the COs and POs. The questions must address the POs mapped in the CO-PO articulation matrix. It is unnecessary to give a question that will neither address any of the PO's in the question paper as the objective of the assessment is to finally address the attainment of the PO's. The assessment should intend the measurement of the PO's and also must correlate the CO.

G. Determination of CO attainment

CO attainment is done using two methods – (i) Student wise attainment method and (ii) Cohort method. The following steps are implemented in arriving Student wise attainments (SWA)

1. A detailed statement of question wise marks scored by each student is prepared while citing the COs mapped to each question in the assessment as in Table 6.

The datasheet is shown in Figure 4.

Table 6. Question wise marks

Assessment Name: Internal Examination			All Questions to be answered			Two out of three to be answered		
S.No	Hall ticket no.	Student Name	Part A			Part-B		
		CO mapped	Q1	Q2	Q3	Q4	Q5	Q6
		Maximum Marks	2	2	2	7	7	7
1	1602-12-732-XX1	Student 1	1	1	0	NA	5	4
2	1602-12-732-XX2	Student 2	2	1	1	4	5	NA
3	1602-12-732-XX3	Student 2	1	2	2	5	5	NA

Internal Exam			All Questions to be answered						Two out of three to be answered			
No	HTNO	CO	Part A						Part-B			
			Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8A	Q8B	Q9
			Max. Marks	1	1	1	1	1	1	7	3	4
1	1602-12-732-001	ABHI MUKESH SHRIVAS	1		1	1	1	1	NA	3	4	5
2	1602-12-732-002	MALLIGONDA ABHILESH				1	1	0.5	NA	3	4	7
3	1602-12-732-003	AFSHA NOOR		0.5					NA	3	4	4
4	1602-12-732-004	PALLAPOLU AKHIL KUMAR REDDY			0.5	1	1	1	4.5	NA	NA	3
5	1602-12-732-005	RAJARAJU AKHIL RAJ	0.5		1		1	1	NA	3	0	5
6	1602-12-732-006	CHINTAMAL A AKHILA			1	1	1	1	NA	3	4	1.5
7	1602-12-732-007	BANUDEEP REDDY			1	1	1		NA	3	3	7
8	1602-12-732-008	MANGALAPALLY ARUN KUMAR		1	1	1	1		NA	3	4	6
9	1602-12-732-009	ADAPA CHAITANYA REDDY			1	1	1		NA	2	2	6.5
10	1602-12-732-011	GOPU RAJU		1	1				NA	3	3	6
11	1602-12-732-012	THIRUVALLURI HANNA DEEPTHI		1	1				1	NA	NA	4.5
12	1602-12-732-013	MARAM HAREESH	1	1	1	1	1	1	5	3	2	NA
13	1602-12-732-015	T HIMA SREE BINDU		1	1	1	1	1	NA	3	2	4
14	1602-12-732-016	YALLABANDI KARTIKESH			1	1	1	1	NA	2	4	4
15	1602-12-732-017	DURGAPATI HIKIRAN		1	1	1		1	NA	3	4	5
16	1602-12-732-018	MADASU LALITANJANI			1		1		NA	2.5	1	4
17	1602-12-732-019	Mahesh A				1		1	2	2	0	NA

Figure 3. Datasheet for question wise marks

2. Maximum marks and total marks scored by each student CO-wise are then computed by taking summation of marks assigned to all questions mapped to a particular CO as shown in Table 7. Since each student is free to choose any 2 questions out of 3 in PART-B as Table 6, the distribution of total maximum marks CO-wise will not remain same to all students.

3. Student wise Attainments (SWA) are determined as ratio of marks scored to maximum marks

$$\text{Student1 CO4 attainment} = \frac{\text{Total marks scored for CO4}}{\text{Maximum marks of CO4}}$$

Table 7. Student wise -CO attainments

Assessment Name	Internal Examination	CO wise marks				Student wise-CO attainments %		
No	HTNO	Stu. Name	Maximum Marks		Marks scored			
		CO	C04	C05	C04	C05	C04	C05
		Max. Marks	9	18			100	100
1	1602-12-732-XX1	Student 1	2	18	1	10	50	56
2	1602-12-732-XX2	Student 2	9	11	6	7	67	64

The datasheet for student wise attainments is shown in figure 4.

CO wise marks						Student wise -CO attainments		
MaximumMarks			Marks scored			MaximumMarks		
C03	C04	C05	C03	C04	C05	C03	C04	C05
13	8	6				100	100	100
6	8	6	5	6	6	83.4	75	100
8	8	6	4	7	5.5	66.7	87.5	91.7
8	8	6	3.5	4	4	38.4	50	66.7
10	8	2	5.5	3.5	2	55	43.8	100
6	8	6	3.5	6	2	58.4	75	33.4
8	8	6	4	2.5	6	66.7	31.3	100
6	8	6	4	8	4	66.7	100	66.7
6	8	6	5	7	5	83.4	87.5	83.4
6	8	6	3	7.5	3	50	93.8	50
6	8	6	4	7	3	66.7	87.5	50
10	8	2	2	5.5	0	20	68.8	0
13	1	6	11	1	4	84.7	100	66.7
6	8	6	5	5	4	83.4	62.5	66.7
6	8	6	3	5	6	50	62.5	100
6	8	6	5	6	5	83.4	75	83.4
6	8	6	2.5	5	2	41.7	62.5	33.4
13	1	6	5	0	1	38.5	0	16.7
13	1	6	11	1	6	84.7	100	100
13	1	6	11	1	6	84.7	100	100
13	1	6	10	1	6	77	100	100
6	8	6	2.5	6.5	2	41.7	81.3	33.4
10	8	2	3	2	1	30	25	30

13	1	6	9.5	1	6	73.1	100	100	
13	1	6	10	0	8	77	0	100	
10	8	2	7.5	4.5	2	75	56.3	100	
6	8	0	5	7	8	83.4	87.5	100	
6	8	6	4	8	6	66.7	100	100	
13	1	6	7	1	2	33.9	100	33.4	
10	8	2	8	7	2	80	87.5	100	
6	8	6	3	5.5	5	50	68.8	83.4	
10	8	2	2.5	0	1	25	0	50	
13	1	6	11	1	6	84.7	100	100	
13	1	6	10.5	1	6	80.8	100	100	
6	8	6	2	5	1	33.4	62.5	16.7	
13	1	6	4	1	5	38.8	100	83.4	
13	1	6	10	1	6	77	100	100	
6	8	6	1.5	0	3	25	0	50	
13	1	6	6	1	1	46.2	100	16.7	
8	8	6	1	3	8	50	37.5	100	
6	8	6	2.5	8	5.5	41.7	100	91.7	
6	8	6	3	3	2	50	37.5	33.4	
6	8	6	1	6	6	50	75	100	
10	8	2	5	5	2	50	62.5	100	
6	8	6	4	7	6	66.7	87.5	100	
13	1	6	11.5	0	6	88.5	0	100	
13	1	6	12	1	6	92.4	100	100	
6	8	6	4	5.5	5	66.7	88.8	83.4	
6	8	6	4	5	6	66.7	62.5	100	
6	8	6	3	3	2	50	62.5	33.4	
6	8	6	2.5	4.5	5	41.7	56.3	83.4	
6	8	6	4	7	3.5	66.7	87.5	58.4	
6	8	6	4	6.5	6	66.7	81.3	100	
6	8	6	3.5	6	5.5	58.4	75	91.7	
6	8	6	3.5	7.5	1	58.4	93.8	16.7	
13	1	6	12	1	6	92.4	100	100	
6	8	6	4.5	8	6	75	100	100	
13	1	6	5.5	1	1	42.4	100	16.7	
6	8	6	1	4	4	50	50	66.7	
6	8	6	2.5	6.5	5.5	41.7	81.3	91.7	
6	8	6	4	5	5.5	66.7	62.5	91.7	
13	1	6	11	0	6	84.7	0	100	
13	1	6	9.5	0	5	73.1	0	83.4	
6	8	6	3	4	5	50	50	83.4	
13	1	6	6	1	2	46.2	100	33.4	
6	8	6	4	3	2	66.7	37.5	33.4	
13	1	6	10	0	4	77	0	66.7	
6	8	6	4	7.5	2	66.7	93.8	33.4	
6	8	6	2	5	3	33.4	62.5	50	
						Nb of students >60 % of marks	37.6	50.0	47.0
						Total No of students	68	68	68
						%			
						attainment	54.5	73.6	89.2

Figure 4. Datasheet for student wise attainment

4. Percentage CO attainment of whole class is determined as percentage of students scoring more than or equal to the thresholds established at the program level.

The following steps are implemented in arriving cohort's attainment (COHA)

- a. A detailed statement of question wise marks scored by each student is prepared while citing the COs mapped to each question in the assessment as in Table 6
- b. Number of students attempting each question is noted (C1) as student can choose to attempt any 2 questions out of 3 in PART-B as Table 6
- c. Number of students scoring greater than or equal to threshold mark of each question is noted (C2)
- d. Percentage attainment is computed as ratio of C2 to C1 as described
- e. Further average of attainments pertaining to each CO is computed as shown in table 8. The corresponding datasheet is shown in figure 5.

Table 8. CO attainment calculation using Cohort method

Threshold marks of each question	1.2	1.2	1.2	4.2	4.2	4.2	Average
Number of students attempting the question (c1)	70	70	70	53	54	22	
No of Students >= Threshold marks (c2)	57	54	48	38	34	5	
% of students >= Threshold%	81.5	77.2	68.6	71.7	63	22.8	
CO4	81.5			71.7			76.6
CO5		77.2	68.6		63		69.6

The table displays individual student performance across 13 questions. Each row represents a student, and columns show scores for different parts of the assessment (Part A and Part B). The 'Two out of three to be assessed' section highlights the scores for the questions that were actually attempted by each student.

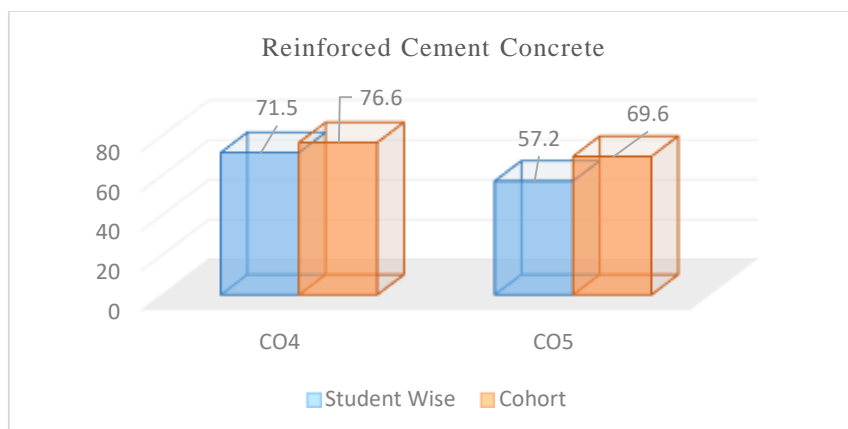


Figure 8. Comparison of SWA and COHA- Reinforced Concrete Design

The results of the comparison of both the methods show that the values of attainment differ in both the methods but they fall under the same level of attainment. Hence, any method could be adopted for CO attainment calculation. But the student wise attainment has an advantage when compared to the Cohort method. Student portfolios can be established with student wise analysis. The data obtained from CO attainment analysis is taken and with the CO – PO mapping matrix , PO attainments are determined for each subject giving relative weightage to CO-PO mapping weight. The data obtained for one sample student for all the subjects he studies in each semester is shown in the table 9.

Table 9. Sample PO attainments of a student in eight semesters.

Semester/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Semester 1	2.5	2.37	2.5	2.3	2.8				2.03	2		2.42
Semester 2	2.52	2.39	2.22	2.5	3				2.6	2.17	2.3	2.51
Semester 3	2.66	2.67	2.12	2.2	2.63	2.7	2.63	2.75	2.9	2.73	2.8	2.65
Semester 4	2.83	2.74	2		3	2.93	2.95	2.95	3	2.72		2.78
Semester 5	2.63	2.56	1.85	2.1	2.84	2.65	2.65	2.98	2.8	2.1	3	2.74
Semester 6	2.48	2.39	2.25	2.41	2.85	2	2.43	2.67	2.78	3		2.63
Semester 7	2.59	2.6	2.35	2.38	2.7	2.7	2.6	2.75	2.47	2.78	2.33	2.6
Semester 8	3	2.92	2.93	2.96	2.98	2.97	3	3	2.85	3	2.85	2.95
Average	2.65	2.58	2.28	2.41	2.85	2.66	2.71	2.85	2.68	2.56	2.66	2.66

The average of all values of each PO are obtained for each student as shown in table 9. This table represents the student strengths and weaknesses in each graduate attribute. This shows the entire profile of the student over a time. Each student data can be analysed and recommendations can be given personally to students to improve his weaknesses. The Proposed recommendations for the student attainments at PO level are given in table 10.

Table 10. Proposed recommendations for the student attainments at PO level.

PO	Graduate attribute	Scope for placements
1	Engineering knowledge	Core Engineering companies
2	Problem analysis	Higher education and research laboratories
3	Design / Development of solutions	Core Discipline design companies
4	Conduct investigation of complex problems	Core Discipline design companies
5	Modern tool usage	Software companies / Tool development
6	Engineer and Society	NGOs and Public sector undertakings working for infrastructure development
7	Environment and Sustainability	Core Engineering companies, NGOs and Public sector undertakings working for infrastructure development
8	Ethics	Any company
9	Individual and Team work	Any company
10	Communication	Any company
11	Project Management and Finance	Construction management projects and their allied companies
12	Lifelong learning	Companies with constantly upgrading technologies and needs self learning capabilities, Entrepreneur

In the above table 10, the student has displayed strong strength in modern tool usage. Student can be further groomed in modern tools to achieve higher placements.

CONCLUSION

This study has found that the values of course outcomes obtained from student wise computation and question wise computation are almost same. The tool used for calculation of course outcomes from student wise computation will be helpful in measuring student portfolios with direct assessment technique and can be an aid to the institute as well as students to understand his / her strengths and weaknesses at regular intervals ie, at the end of each semester.

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