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Assessment and Attainment of Course Outcome of Computer Aided Engineering Course

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Abstract: *This study explores the assessment and attainment of Course Outcomes (COs) within the Outcome-Based Education (OBE) framework. It outlines the process of mapping COs to assessment tools, including both direct and indirect assessment methods. The weighted average method is used to calculate CO attainment levels, assigning weights based on each tool's maximum marks. The study analyzes CO attainment levels achieved through these assessment tools, providing insights into OBE implementation and effective CO assessment*

Keywords: Course Outcome, Assessment, Attainment, Outcome Based Education, weighted average method

I. INTRODUCTION

Outcome-Based Education (OBE) focuses on aligning the teaching process with Course Outcomes (COs) to ensure students acquire necessary knowledge, skills, and competencies. Assessment tools in OBE, both direct (e.g., assignments, exams) and indirect (e.g., surveys), measure students' performance and CO attainment. Direct tools include internal assessments by course teachers and external standardized tests. This paper examines CO assessment in the Computer Aided Engineering course within a Mechanical Engineering program, using a weighted average method to calculate CO attainment based on various assessment tools.

II. LITERATURE REVIEW

Numerous studies have explored Outcome-Based Education (OBE) in higher education. Vivek et al. found that digital teaching tools positively impact Course Outcome (CO) attainment, enhancing cognitive, psychometric, and affective learning levels. Rawat et al. emphasized the importance of assessing COs using various tools in an Applied Physics course for diploma engineering students.

Akash discussed OBE implementation in Indian engineering colleges, focusing on Program Outcomes (PO) and Program Educational Objectives (PEOs) for postgraduate programs using direct and indirect tools. Masni-Azian et al. analyzed CO and PO attainment in a Product Design and Development course at UniversitiTeknikal Malaysia Melaka, employing direct and segregated measurements.

Soragaon et al. introduced a simplified approach for measuring CO, PO, and Program Specific Outcomes (PSOs) in Tier-II engineering institutions. Sawant examined CO attainment in a Discrete Mathematics course using an automated system, IONCUDOS, applying both direct and indirect methods.

Agrawal et al. highlighted the need for changes in teaching and assessment methods for effective OBE implementation in Tier-I technical institutes. Dilip proposed a rubric-based mathematical model for evaluating CO and PO attainment, adaptable to any program. Dandin et al. described a method for evaluating CO attainment in a Computer Networking course in diploma engineering.

III. METHODOLOGY

Course Outcome statements:

Course Outcomes are designed to assess the core competencies that a student should acquire by the end of a Computer Aided Engineering course.

CO.1 Apply fundamental principles of engineering design and analysis to solve problems using Finite Element Method.

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CO.2 Develop proficiency in using1D, 2D and 3D elements for Finite Element Analysis.
CO.3 Evaluate and solve non-linear and dynamic analysis problems by analyzing the results obtained from analytical and computational method.
CO.4 Communicate effectively through clear and concise reports and presentations of engineering analysis results.
CO.5 Demonstrate ability to understand industry-standard software applications for computer aided engineering.
CO.6 Demonstrate the ability to optimize engineering designs using computer-aided engineering simulations
The Course Outcomes (COs) define the essential skills and knowledge students should acquire by the end of the course. They focus on applying fundamental engineering principles (CO.1), developing proficiency in Finite Element Analysis (CO.2), solving complex non-linear and dynamic problems (CO.3), effectively communicating analysis results (CO.4), understanding and using industry-standard CAE software (CO.5), and optimizing engineering designs through CAE simulations (CO.6). These outcomes are crucial for preparing students for success in the engineering field.

Assessment Tools:

Direct Internal Assessments:

- Class Tests: Five tests assess CO.1 to CO.4 by evaluating students' application of engineering principles, understanding of Finite Element Analysis, and ability to solve and interpret non-linear and dynamic analysis problems.
- Assignments: Tasks focused on optimizing engineering designs using CAE simulations.
- Case Study: Groups of 3-4 students work on real-life engineering problems, producing detailed reports on their findings and solutions.

Direct External Assessments:

- Theory Examinations: Two written exams (in-sem and end-sem) and a practical exam, conducted by the affiliated university, assess students' understanding and application of fundamental CAE principles.
- Computer-based Practical Exam: Assesses students' proficiency in industry-standard CAE software through specific tasks, conducted by the university.

Indirect Assessment:

- Survey: Conducted at the end of the course to evaluate students' perceptions of their attainment of Course Outcomes, with responses aligned to COs on a scale of 1 to 3.

Mapping of CO and assessment tools

- Mapping of CO and assessment tools involves identifying which assessment tools should be used to measure each Course Outcome (CO). This ensures that the assessment methods align with the intended learning outcomes of the course. Table – I show the mapping of assessment tools and the six COs.

TABLE I: MAPPING OF CO AND ASSESSMENT TOOLS

Course Outcomes	Internal Assessment Tools								External Assessment Tools		
	Test-1	Test -2	Test-3	Test -4	Test-5	Assignment - 1	Assignment-2	Case Study	In-Sem	End-Sem	Practical
CO.1	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
CO.2	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
CO.3				Yes	Yes		Yes			Yes	Yes
CO.4	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
CO.5								Yes		Yes	Yes
CO.6								Yes			Yes

Calculations for Course Outcome Attainment:

Attainment Levels:

- Level 1: 40% to less than 60% of students score more than 60% Marks
- Level 2: 60% to less than 70% of students score more than 60% Marks
- Level 3: More than 70% of students score more than 60% Marks

Attainment is calculated by the percentage of students meeting or exceeding a 60% threshold marks in assessments.

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Attainment level achieved by all the tools used for assessment: The data in Table II is analyzed to determine the attainment level for each tool used.

TABLE II: STUDENTS PERFORMANCE IN EACH TOOL USED

Tools	Test-1	Test-2	Test-3	Test-4	Test-5	Assi.-1	Assi-2	Case Study	In-Sem	PR	End Sem
Total Students appeared	59	72	79	72	76	82	87	87	86	86	86
No of Students Scoreing >= 60 %	28	46	73	49	50	82	87	84	30	29	47
% of Students Scoreing >= 60 %	47%	64%	92%	68%	66%	100%	100%	97%	35%	34%	55%
Tool Attainment	1	2	3	2	2	3	3	3	1	1	1

Weighted Average Method for CO Attainment:

To calculate Course Outcome (CO) attainment, the weighted average method is used. When an assessment tool measures multiple COs, its attainment level is applied to each CO. Weights are assigned to each tool based on its maximum marks, and the tool's attainment level is multiplied by its weight. These weighted values are summed to obtain the CO attainment level.

Overall CO attainment for a course is calculated using both direct (80% weightage) and indirect (20% weightage) assessment tools. Internal assessment tools are weighted at 20%, while external tools are weighted at 80%, ensuring a comprehensive evaluation of student performance.

Table – III shows the distribution of marks for each mapped CO by all the tools used in the assessment process. It is considered that the question papers are set by assigning equal marks to each CO mapped.

TABLE III: MARK DISTRIBUTION TO COS

Mark Distribution													
	Internal Assessment Tools									External Assessment Tools			
	Test-1	Test-2	Test-3	Test-4	Test-5	Assi.-1	Assi-2	Case Study	Total	In-Sem	PR	End Sem	Total
Marks	20	20	30	20	20	20	20	20	170	30	50	70	150
CO-1	6.67	6.67	10.00	5.00	5.00	6.67	5.00	4.00	49.00	10.00	8.33	14.00	32.33
CO-2	6.67	6.67	10.00	5.00	5.00	6.67	5.00	4.00	49.00	10.00	8.33	14.00	32.33
CO-3				5.00	5.00		5.00		15.00		8.33	14.00	22.33
CO-4	6.67	6.67	10.00	5.00	5.00	6.67	5.00	4.00	49.00	10.00	8.33	14.00	32.33
CO-5								4.00	4.00		8.33	14.00	22.33
CO-6								4.00	4.00		8.33		8.33

TABLE IV: SHOWS THE WEIGHTAGE ASSIGNED TO EACH TOOL USED IN THE ASSESSMENT PROCESS.

Weightage													
	Internal Assessment Tools									External Assessment Tools			
	Test-1	Test-2	Test-3	Test-4	Test-5	Assi.-1	Assi-2	Case Study	Total	In-Sem	PR	End Sem	Total
CO-1	0.14	0.14	0.20	0.10	0.10	0.14	0.10	0.08	1.00	0.31	0.26	0.43	1.00
CO-2	0.14	0.14	0.20	0.10	0.10	0.14	0.10	0.08	1.00	0.31	0.26	0.43	1.00
CO-3				0.33	0.33		0.33		1.00		0.37	0.63	1.00
CO-4	0.14	0.14	0.20	0.10	0.10	0.14	0.10	0.08	1.00	0.31	0.26	0.43	1.00
CO-5								1.00	1.00		0.37	0.63	1.00
CO-6								1.00	1.00		1.00		1.00

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TABLE V: SHOWS THE CALCULATION OF CO ATTAINMENT BY WEIGHTED AVERAGE METHOD FOR INTERNAL AND EXTERNAL ASSESSMENT TOOLS

CO attainment By Internal and External Assessment Tools													
	Internal Assessment Tools									External Assessment Tools			
Tool Attainment	Test-1	Test-2	Test-3	Test-4	Test-5	Assi-1	Assi-2	Case Study	CO Attainment	In-Sem	PR	End Sem	CO Attainment
	1	2	3	2	2	3	3	3		1	1	1	
CO-1	0.14	0.27	0.61	0.20	0.20	0.41	0.31	0.24	2.39	0.31	0.26	0.43	1.00
CO-2	0.14	0.27	0.61	0.20	0.20	0.41	0.31	0.24	2.39	0.31	0.26	0.43	1.00
CO-3				0.67	0.67		1.00		2.33		0.37	0.63	1.00
CO-4	0.14	0.27	0.61	0.20	0.20	0.41	0.31	0.24	2.39	0.31	0.26	0.43	1.00
CO-5								3.00	3.00		0.37	0.63	1.00
CO-6								3.00	3.00		1.00		1.00

20% weightage is assigned to internal assessment tool while 80% weightage is assigned to external assessment tool. Table – VI shows the calculations for CO attainment by direct assessment tools.

TABLE VI: CO ATTAINMENT BY DIRECT ASSESSMENT TOOL

CO Attainment by Direce Assessment Tools			
CO	Internal (20%)	External (80%)	CO Attainment
CO-1	2.39	1.00	1.28
CO-2	2.39	1.00	1.28
CO-3	2.33	1.00	1.27
CO-4	2.39	1.00	1.28
CO-5	3.00	1.00	1.40
CO-6	3.00	1.00	1.40

At the end of the course, a course end survey is administered to the students. The survey questions are mapped with the six COs of the course. The students' responses to the survey questions are collected on a scale of 1 to 3. The average of all the responses is considered as the CO attainment level achieved by using an indirect assessment tool. Table – VII displays the CO attainment values.

TABLE VII: CO ATTAINMENT BY COURSE END SURVEY

Course End Survey						
Course Outcomes	CO.1	CO.2	CO.3	CO.4	CO.5	CO.6
Attainmet	2.52	2.35	2.38	2.27	2.42	2.42

Table – VIII displays the final CO attainment for the course by assigning 80% weightage to direct assessment tools and 20% weightage to indirect assessment tools.

TABLE VIII: CO ATTAINMENT FOR COURSE

CO Attainment for Course			
CO	Direct (80%)	Indirect (20%)	CO Attainment
CO-1	1.28	2.52	1.53
CO-2	1.28	2.35	1.49
CO-3	1.27	2.38	1.49
CO-4	1.28	2.27	1.48
CO-5	1.40	2.42	1.60
CO-6	1.40	2.42	1.60

IV. RESULTS AND DISCUSSION

The assessment results for the Computer Aided Engineering course show that internal assessment tools have higher attainment values than external ones. Students achieved moderate competency across all course outcomes (COs). CO.1, CO.2, and CO.3 have similar attainment levels, indicating comparable proficiency in applying engineering principles, using elements for finite element analysis, and solving non-linear and dynamic problems. CO.4, CO.5, and CO.6 also

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show similar attainment levels, reflecting students' competency in communicating results, understanding CAE software, and optimizing designs. These findings underscore the importance of using multiple assessment tools in the OBE framework.

V. CONCLUSION

This research demonstrates the successful implementation of the OBE framework for assessing and attaining course outcomes in higher education. Using both direct and indirect assessment tools, including internal and external assessments, provided a comprehensive evaluation. The weighted average method ensured fair and accurate representation of student performance. Future research should explore the effectiveness of different assessment tools and the use of technology, such as online assessments and automated grading systems, to improve accuracy and efficiency.

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