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A Structured Approach for Assessment and Attainment of Program Outcomes under NBA Criterion 3 using an Excel-Based Evaluation Tool

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Abstract- Outcome-Based Education (OBE) has become an essential framework for engineering education under the National Board of Accreditation (NBA). Criterion 3 of NBA focuses on the evaluation and attainment of Program Outcomes (POs) through measurable and transparent processes. This paper presents a structured and practical methodology for calculating CO and PO attainment using an Excel-based automated tool. The methodology integrates both direct and indirect assessment techniques and provides a systematic approach for data collection, analysis, and interpretation. A case study from a Mechanical Engineering course is included to demonstrate real implementation.

Keywords: Outcome-Based Education (OBE), NBA Accreditation, Program Outcomes (POs), Course Outcomes (COs), Attainment Calculation, Direct Assessment, Indirect Assessment, Excel Automation, Engineering Education, Continuous Improvement.

I. INTRODUCTION

In recent years, engineering education has shifted from a teacher-centered approach to a learner-centered approach known as Outcome-Based Education (OBE). This approach emphasizes what students are able to do at the end of a course or program rather than what is taught in the classroom. The National Board of Accreditation (NBA) has adopted OBE as a mandatory requirement for accreditation. Among all criteria, Criterion 3 plays a crucial role as it focuses on defining Program Outcomes (POs), Course Outcomes (COs), and measuring their attainment.

However, calculating attainment manually is complex and prone to errors, especially when dealing with large datasets. Therefore, an Excel-based tool is used to automate the process. This paper aims to explain a structured methodology for attainment calculation using such tools and demonstrates its practical implementation in a Mechanical Engineering course.

II. PROGRAM OUTCOMES (POS)

Program Outcomes (POs) represent the knowledge, skills, and attitudes that students acquire upon the completion of a specific program. While there are eleven POs defined for degree-level engineering courses, this paper focuses on the seven program outcomes specific to the diploma level.

The outcomes are defined as follows:

- PO1 | Basic and Discipline-specific knowledge: Apply knowledge of basic mathematics, science and engineering fundamentals and engineering specialization to solve the engineering problems.
- PO2 | Problem analysis: Identify and analyse well-defined engineering problems using codified standard methods.

- PO3 | Design/ development of solutions: Design solutions for well-defined technical problems and assist with the design of systems components or processes to meet specified needs.

- PO4 | Engineering Tools, Experimentation and Testing: Apply modern engineering tools and appropriate techniques to conduct standard tests and measurements.

- PO5 | Engineering practices for society, sustainability and environment: Apply appropriate technology in context of society, sustainability, environment and ethical practices.

- PO6 | Project Management: Use engineering management principles individually, as a team member or a leader to manage projects and effectively communicate about well-defined engineering activities.

- PO7 | Life-long learning: Ability to analyse individual needs and engage in updating in the context of technological changes.

III. COURSE OUTCOMES (COS)

In the diploma curriculum affiliated with the Maharashtra State Board of Technical Education (MSBTE), Course Outcomes (COs) are predefined for every subject. These outcomes represent the specific competencies a student should acquire upon completing a particular course.

The Review and Revision Process
While the MSBTE provides a standard set of COs, the academic framework allows for internal validation to ensure quality and relevance:

- Syllabus Review: The Course Coordinator performs a comprehensive review of the syllabus and the associated topics.

- Validation of COs: The coordinator evaluates whether the board-provided COs fully encompass the depth and breadth of the course content.
- Revision and Customization: If the standard COs are found to be insufficient or if they do not align perfectly with the delivery of the topic, the Course Coordinator has the authority to revise or refine them. This ensures that the outcomes remain measurable and achievable.

- Quantity: Depending on the complexity and volume of the syllabus content, each subject typically consists of five to six Course Outcomes.

Significance of Cos
These outcomes serve as the foundation for Outcome-Based Education (OBE). They act as a bridge between the classroom teaching and the broader Program Outcomes (POs). By achieving these five or six specific targets per subject, students systematically progress toward the attainment of the seven mandatory POs required for a diploma in engineering.

IV. PROGRAM SPECIFIC OUTCOMES (PSOS)

While Program Outcomes (POs) represent broad skills common to all engineering disciplines, Program Specific Outcomes (PSOs) are statements that define what graduates of a specific engineering program should be able to do. These are specifically tailored to the unique technical requirements of a particular branch of study.

Key Characteristics of PSOs:
Department Specificity: PSOs are unique to each department. For instance, the PSOs for Civil Engineering will focus on surveying and construction, while PSOs for Computer Engineering will focus on software development and networking. Industry Alignment: They are developed based on the specific needs of the industry and the current technological trends relevant to that branch.

- Quantity: Typically, each program defines two to four PSOs in addition to the seven mandatory POs.

- Complementary Nature: PSOs do not replace POs; rather, they complement them by adding a layer of specialized technical depth.

V. DEVELOPMENT AND REVIEW

In the context of MSBTE-affiliated institutes, PSOs are usually drafted by the Departmental Advisory Board or the Program Coordinator. They ensure that the specific curriculum provided by the board effectively translates into specialized skills that make the student "industry-ready" in their particular field. Course Outcomes (COs) and Program Outcomes (POs) / Program Specific Outcomes (PSOs) Mapping Serve as specific, measurable objectives for individual subjects and are typically structured according to the cognitive levels of Bloom's Taxonomy. To determine the degree to which Program Outcomes are achieved, each CO is systematically linked to the relevant POs using a Correlation Matrix.

This mapping process quantifies the strength of the relationship between the subject matter and the broader program goals. The levels of correlation are standardized as follows:

- Level 1 (Low): The course content has a slight impact on the attainment of the specific Program Outcome.

- Level 2 (Moderate): The course content has a significant and clear relevance to the Program Outcome.

- Level 3 (High): The course content is directly focused on and critical to the fulfillment of the Program Outcome.

VI. ATTAINMENT OF COURSE OUTCOMES

To evaluate the attainment of Course Outcomes (COs), the institution utilizes two primary assessment categories: Internal Assessment (IA) and Board Examination (BE). In alignment with Outcome-Based Education (OBE) principles, the institution employs diverse tools to identify, collect, and analyze data regarding student performance.

The CO attainment process is governed by a hierarchical structure to ensure academic integrity and quality:

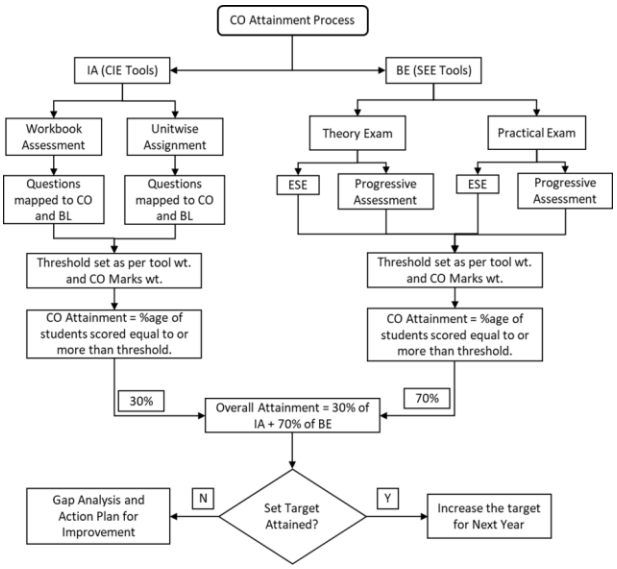
- Institution Curriculum Implementation Unit (ICIU): Provides guidelines to the Departmental Advisory Board (DAB) for preparing assessment tools. The ICIU approves the OBE implementation process by analyzing feedback from the Internal Academic Monitoring Committee (IAMC) and recommending improvements.

- Departmental Advisory Board (DAB): Responsible for designing the specific assessment tools for outcome measurement and formulating the technical requirements for OBE implementation.

- Internal Academic Monitoring Committee (IAMC): Effectively monitors the implementation of OBE and ensures that the DAB-provided and ICIU-approved tools are used consistently.

- Course Coordinator: Formulates the COs and performs the CO-PO/PSO mapping with detailed justification.

- Module Coordinator: Verifies the COs and mapping justifications provided by the Course Coordinator to maintain curriculum alignment.



VII. ASSESSMENT METHODOLOGIES

A. Internal Assessment (IA)

The IA primarily consists of workbook assessments and unit-wise assignments.

The calculation follows these guidelines:

- Workbook Assessment: Every question is mapped to a specific CO. A student is classified as an 'M' student (Meeting attainment) for a specific CO if they score above the calculated Threshold Marks.
- Assignments: Specific assignments are designed for each CO. Attainment is calculated using the same threshold principle as the workbook.
- Data Integration: The final IA score is a cumulative reflection of data gathered from both workbooks and assignments.

B. Board Examination (BE)

The BE reflects performance in laboratory work, progressive assessments, and final examinations conducted under MSBTE norms.

- Laboratory & Practical Assessment: Continuous evaluation is based on experiment performance and results. Lab manual marks (out of 25) are split into Process Related (15 marks) and Product Related (10 marks).
- External Evaluation: Final practical and oral examinations are conducted by MSBTE-appointed external examiners to validate technical skills.
- Theory Examinations: End-semester theory (ESE) and progressive assessments (PA) serve as the primary data points.
- Calculation: The percentage of marks obtained in TH-ESE, TH-PA, PR-ESE, and PR-PA is split according to CO weightage. Students scoring above the threshold level contribute to the final BE attainment.

VIII. CALCULATION OF OVERALL CO ATTAINMENT

The final attainment for each course is a weighted combination of the internal and board assessments. Individual faculty members calculate this using the following standardized protocol:

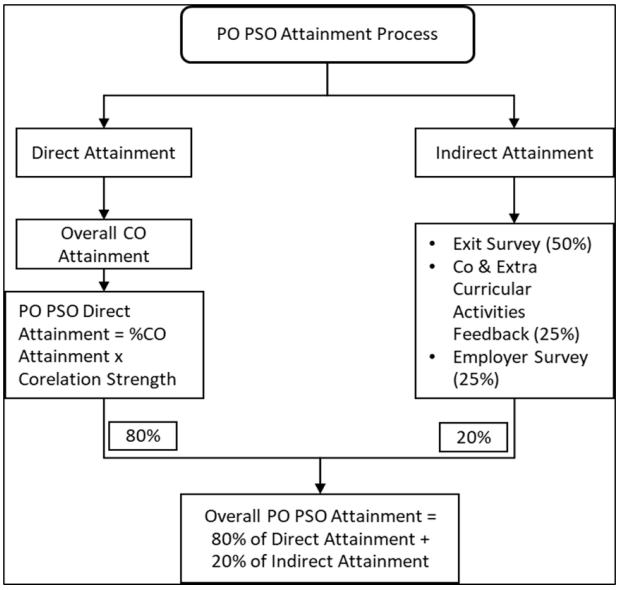
Weightage Distribution:

- 30% from Internal Assessment (IA)
- 70% from Board Examination (BE)
- Attainment of Program Outcomes (POs) & Program Specific Outcomes (PSOs)

The assessment of Program Outcomes (POs) and Program Specific Outcomes (PSOs) is a comprehensive process that evaluates whether Mechanical Engineering graduates have achieved the expected level of proficiency. The institution utilizes two distinct assessment categories: Direct Attainment and Indirect Attainment.

1. Direct PO/PSO Attainment Direct attainment reflects the measurable knowledge and technical skills demonstrated by students through their academic performance.

Source Material: This data is directly derived from the Course Outcome (CO) attainment values calculated.
Process: The performance in Internal Assessments (IA) and Board Examinations (BE) serves as primary evidence of student learning. The CO attainment of each course is mapped to the corresponding POs and PSOs via the articulation matrix to compute the direct contribution of each subject to the program goals.



2. Indirect PO/PSO Attainment Indirect attainment captures the opinions and perceptions of stakeholders regarding the program's effectiveness. This category includes:

Employer and Exit Surveys: These evaluate the professional readiness of students from the perspective of industry recruiters and graduating students.

Co-curricular and Extra-curricular Activities: Feedback from expert lectures, industrial visits, technical workshops (co-curricular), and social or cultural events (extra-curricular) is analyzed. These activities are assessed using outcome-based feedback forms to determine their contribution to PO attainment.

Weightage Distribution for Indirect Attainment:

- Exit Survey: 50%
- Employer Survey: 25%
- Activity Feedback (Co-curricular/Extra-curricular): 25%

3.3.2. Calculation of Overall PO and PSO Attainment

The final attainment level for each PO and PSO is determined by combining direct and indirect measures according to the following guidelines:

- Weighted Integration: Overall attainment is calculated by assigning 80% weightage to Direct Attainment and 20% weightage to Indirect Attainment.
- Setting Targets: The benchmark for overall PO/PSO attainment is determined by the average value of the Course-PO/PSO correlation articulation matrix.
- Continuous Improvement: If the established PO/PSO targets are successfully achieved, the department sets higher target values for CO attainment in the subsequent academic cycle to foster a culture of excellence.

IX. CASE STUDY: CO-PO ATTAINMENT ANALYSIS

Course Context and Assessment Framework

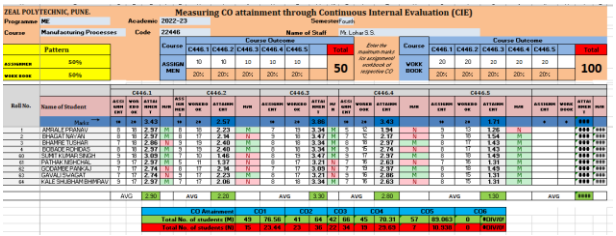
The course is evaluated using a dual-component assessment strategy: Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE). For the 2022-23 cycle, the institution utilized a weightage of 30% for CIE and 70% for SEE to calculate final attainment.

Step 1: Continuous Internal Evaluation (CIE)

CIE measures student progress through assignments and workbook assessments. Each tool is weighted equally at 50% within the CIE category.

Threshold Methodology: Thresholds were established for each Course Outcome (C446.1 to C446.5). For example, the threshold for C446.1 was set at 3.43 marks.

Results: In this cycle, 76.56% of students met the threshold for C446.1, while 89.06% (the highest internal attainment) achieved the threshold for C446.5.

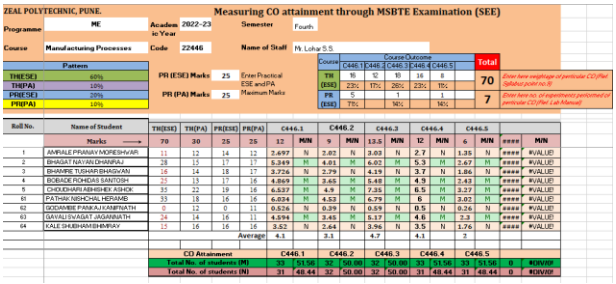


Step 2: Semester End Examination (SEE)

The SEE evaluates students through theory exams (ESE/PA) and practical/oral exams.

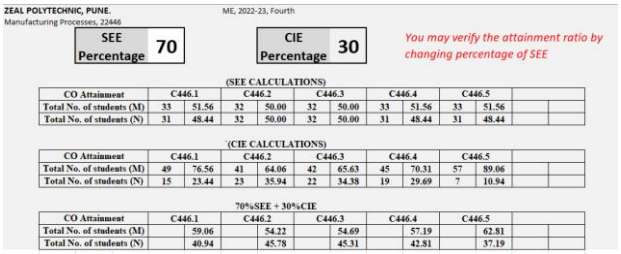
Assessment Pattern: The theory component (ESE) accounts for 60%, while practical components (PR-ESE and PR-PA) account for 40% of the SEE calculation.

SEE Attainment Performance: Across all five outcomes, approximately 50.00% to 51.56% of students successfully met the established SEE thresholds.



Step 3: Calculation of Final CO Attainment

The final attainment is derived by merging the weighted scores of CIE and SEE.



Step 4: Mapping to Program Outcomes (POs)

The attainment levels for each CO were mapped to the seven Program Outcomes.

Correlation Strengths: Outcomes were mapped with varying strengths (1-Low, 2-Moderate, 3-High). Notably, all outcomes showed a strong correlation (Level 3) with PO4 (Engineering Tools and Testing).

PO Attainment Results: The calculated PO attainment for this course ranged from 0.59 (PO2, PO3) to 1.54 (PO4).

PSO Attainment: The course showed a high contribution to PSO1 (Technical Skill) with a resulting attainment value of 1.77.

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Subject Code 22446

COn	% of Attainment	Attainment Level	Mapping							Attainment						
			PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO1	PO2	PO3	PO4	PO5	PO6	PO7
C446.1	59.06	1	2	1	1	3		2	2	1.18	0.59	0.59	1.77		1.18	1.18
C446.2	54.22	1	2	1	1	3		2	2	1.18	0.59	0.59	1.77		1.18	1.18
C446.3	54.69	1	2	1	1	1		2	2	1.18	0.59	0.59	0.59		1.18	1.18
C446.4	57.19	1	2	1	1	3		2	2	1.18	0.59	0.59	1.77		1.18	1.18
C446.5	62.81	2	2	1	1	3		2	2	1.18	0.59	0.59	1.77		1.18	1.18
		Average	2.00	1.00	1.00	2.60		2.00	2.00	1.18	0.59	0.59	1.54		1.18	1.18

COn	% of Attainment	Attainment Level	Mapping			Attainment		
			PSO1	PSO2	PSO3	PSO1	PSO2	PSO3
C446.1	59.06	1	3	2	2	1.77	1.18	1.18
C446.2	54.22	1	3	2	2	1.77	1.18	1.18
C446.3	54.69	1	3	1	2	1.77	0.59	1.18
C446.4	57.19	1	3	2	2	1.77	1.18	1.18
C446.5	62.81	2	3	2	2	1.77	1.18	1.18
		Average	3.00	1.80	2.00	1.77	1.06	1.18

X. CONCLUSION

This paper presents a structured and efficient approach for evaluating Program Outcome attainment using a spreadsheet-based tool. The methodology aligns with NBA Criterion 3 and ensures accurate, transparent, and consistent assessment.Automation significantly reduces effort, improves reliability, and supports data-driven decision-making in engineering education.

XI. FUTURE SCOPE

Integration with Learning Management Systems Use of Artificial Intelligence for predictive analysis Development of web-based platforms Real-time dashboards for monitoring student performance

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