"An Empirical Case Study on Assessment and Attainment of Course Outcomes, Program Outcomes and Program Specific Outcomes : A Simplified Outcome Based Education (OBE) Approach towards empowering the students for a diploma Engineering program as per Self Assessment Report - Jan.2019".

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Abstract: Education is a process of imparting knowledge, skills, and information from educators to students through teaching, learning, and practice. However, the conventional education system lacks the ability to evaluate students' capabilities effectively. It primarily assesses their learning by encouraging them to reproduce the exact content from textbooks as answers to questions. Nevertheless, the contemporary learning system demands a shift from an output-oriented approach to an outcome-oriented one. In response to this need, the Indian education system has implemented the OBE System, facilitated by the NBA.

In recent years, OBE has become a significant focus for many educational establishments in India, particularly among engineering colleges and universities, due to the mandatory requirement set by the National Board of Accreditation (NBA) for program accreditation. The NBA has introduced a revised edition of the SAR, specifically for engineering colleges, universities in the entire country. This report encompasses nine distinct criteria that evaluate various aspects of diploma engineering education provided by these institutions. The criteria are designed to meticulously evaluate the quality of engineering education provided by various departments affiliated with a Board or University The NBA places emphasis on OBE in order to enhance the standard of all type of education. To measure the program's quality, the NBA has formulated specific program outcomes that graduates are expected to obtain from any educational institute during their course of study.

The effectiveness of any stream relies on achieving CO and PO. However, there appears to be a lack of comprehension among engineering faculty members regarding the calculation of Course Outcome (CO) to Program Outcome (PO) attainment. CO-PO mapping and its attainment calculations are essential components of Outcome-Based Education (OBE), facilitating continuous quality improvement and serving as feedback for the OBE loop.

The NBA has explicitly outlined the OBE system in criteria 2, 3, and 7. This research study aims to enhance course objectives in alignment with outcome-based education principles and update curriculum development accordingly. Its objective is to propose precise assessment techniques and evaluation methods to measure the achievement of CO and POs for Engineering Diploma Programs as defined by the NBA. Implementing this model will significantly enhance the technical knowledge of engineers in the twenty-first century.

Course Outcomes (COs) are specific statements that delineate the intended learning outcomes of a particular course. They provide a clear understanding of what learners are expected to comprehend, the skills they should acquire, the ethical principles they should adhere to, and the knowledge and behaviors they should demonstrate upon completing the course.

While Programme Outcomes (POs) are precise determinable statements that outline the required knowledge, gained skills, and students behaviors are expected to possess upon successful completion of a program of study. POs can be measured

straight way through COs. It is essential to assess and evaluate course outcomes at the end of all courses to determine their attainment.

Criterion 3 specifically evaluates the achievement of POs by assessing the attainment of COs. Additionally, criterion 7 heavily relies on criterion 3, while criterion 2 also bears some dependence on criterion 3. Evaluating the attainment of COs and POs by direct and indirect methods allows for comparing the target level and serves as a measure to ensure the accuracy of CO-PO mapping. This approach provides a simplified yet robust method for computing the achievement of COs and program outcomes and can be reached to evaluate PSOs as well.

To achieve accurate evaluation of COs and POs, it is beneficial to employ an effective strategy that utilizes direct as well as indirect measurement method to evaluate student performance. Internal assessment tests, assignments, and final exams are commonly used in most engineering colleges as direct as well as indirect measurement method to evaluate student performance. Careful selection of assessment tools for CO-PO attainment is crucial to accurately assess students' knowledge and skills.

This paper provides an overview of the methodology employed to examine the achievement of COs and Program Outcomes for the sample subject Advanced Surveying (ASU-22301) in the context of a Civil Engineering program for second year diploma in the 3rd semester, consisting of 66 students. The assessment methodology utilizes data derived from the students' performance in final theory and practical exams. This evaluation process not only takes into account the semester marks but also considers internal credits, practical credits, assignment and micro and major projects, industry internships, and various exit surveys related to Course and Program Outcomes.

To facilitate efficient computation and analysis, a computerized Microsoft Office Excel spreadsheet system has been developed and utilized as part of this methodology. The generated results serve as a valuable tool for continuous quality improvement and informing future course delivery strategies.

Index Terms -**National Board of Accreditation (NBA), All India Council for Technical Education (AICTE), Outcome Based Education (OBE), self-assessment report (SAR) ,MSBTE, CO,PO,PSO, Mapping, Attainment.**

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INTRODUCTION
I. General

The recent revision of the accreditation process by the NBA in New Delhi, aligning it with international accreditation bureau like the ABET and ABEEK. By incorporating the instructional guidelines and basic principles from these processes into engineering programs, accredited institutions can ensure that they meet global standards.

The process of accreditation brings forth several advantages for educational institutions, including: It assists the Institution to identify their abilities, obstacles and future scope, Commence Institutions in the innovative practices and advanced tools of pedagogy, Gives new identity and path, Offers community with trusted information and quality in education. Overall, the process of accreditation plays a pivotal role in promoting continuous improvement, fostering innovation, and ensuring the delivery of high-quality education that meets the expectations of all stakeholders involved. The adoption of Outcome-Based Education (OBE) by the AICTE is influenced by the Washington Accord. OBE represents a significant shift in engineering education worldwide and is embraced by various educational and technical establishments. It emphasizes outcome based study, where engineers are equipped with enhanced discipline knowledge, training skills, and behavior. In OBE, specific goals are established, and pedagogy are meticulously intended and implemented to achieve these goals.

The successful implementation of Outcome-Based Education (OBE) requires a systematic approach. It begins with the identification and establishment of desired or defined outcomes. These outcomes serve as the foundation for designing the program curriculum, determining the appropriate teaching and learning methodologies, and providing the necessary supporting facilities.

Throughout the duration of the program, different gauging tools are employed to evaluate the success of these outcomes. The assessment of Course Outcome attainment is heavily reliant on the scholar's performance, reflected in the marks gained in end semester theory and practical examinations, tests, and the submission of term work. These indicators are used to gauge students' learning achievements.

Given the significance of measuring student learning achievements and the ability to predict future performance, it is essential to employ an effective attainment method. This method ensures accurate measurement of student learning outcomes and provides valuable insights into their future potential.

Program outcomes are a reflection of the abilities, skills, behavior, knowledge, and other attributes that scholars are expected to possess and demonstrate upon completing a program. These goals should be clearly defined, specific, and quantitative. The assessment of Program Outcomes (POs) attainment relies heavily on students' performance and their perceptions gathered through various assessment processes, which serve as indicators of their learning achievements. Consequently, it is crucial to employ an appropriate attainment method to measure students' learning achievements and predict their future performance.

Each educational institute has its own vision, mission and objectives, which serves as the foundation for producing competent students. These institutional goals contribute to enhancing the programs offered by the institution. The programs are designed with expected outcomes that align with the COs. The education policy is currently transitioning from output based

education to OBE. This shift has been launched in institutes through the NBA. Criteria 2nd and 3rd of NBA's accreditation process emphasize the importance of self-assessment reports (SARs) that measure CO, PO, and PSO attainment.

II.OBE and NBA

The NBA has implemented the OBE approach and provided guidelines for institutions to strive for excellence and obtain accreditation. The OBE model holds the dormant to effectively evaluate learning outcomes, encompassing quality such as skills, knowledge, values, and attitudes. It is crucial for students to successfully demonstrate these attributes upon completing the program. In the OBE framework, the quality of teaching is assessed based on the quality of learning outcomes. Therefore, each stream should have well defined outcomes that align with the educational objectives. For every course within the program, Course Outcome (CO) statements are formulated, which are directly linked to the POs. The following are steps involved in the Outcome-Based Education approach and it include:

- Fixing the outcomes, objectives and goals.
- Designing the outcome based procedure.
- Structuring outcome based curriculum.
- Implementation of outcome based teaching and learning.
- Evaluation and examination of outcomes.

III. Overview of Criteria

The NBA revised the accreditation cycle and it has undergone a good transformation from an output based approach to an outcome-based approach, which is applicable to not only Tier-I but also Tier-II academic institutes. The implementation of this new outcome based approach accreditation requires institutions to effectively utilize their autonomy by defining their vision, mission, goals, and engaging in strategic planning. To ensure the provision of outcome-based education in Diploma Engineering programs, the NBA has specified nine criteria. These criteria serve as benchmarks for evaluating the quality and effectiveness of educational programs. The nine criteria specified by NBA for Diploma Engineering programs are as below:

1. Vision, Mission, Program Educational Objectives
2. Program Curriculum and Teaching–Learning Processes
3. Course Outcomes and Program Outcomes
4. Students' Performance
5. Faculty Information and Contributions
6. Facilities and Technical Support
7. Continuous Improvement
8. Student Support Systems
9. Governance, Institutional Support and Financial Resources

IV. Outcome Based Assessment

Outcome oriented assessment (OBA) it is an integral process that involves systematically collection of data to evaluate a scholar's attainment of specific goals. It's designed to support the not only vision statement but also mission statement of the program and establishment by continuously collecting, interpreting, and acting upon relevant data.

OBA focuses on assessing student performance and progress based on predetermined outcomes. These outcomes are specific goals and objectives that reflect the abilities, skills, knowledge that scholar should acquire throughout their educational journey.

Programme Outcomes

Programme Outcomes (POs) are precise determinable statements that outline the required understanding, gained skills, and students behaviors are expected to possess upon successful completion of a program of study.

These outcomes reflect the overall goals and objectives of the program and serve as benchmarks for assessing student achievement. POs are more focused and narrower in scope compared to broader program objectives. They describe the specific competencies and capabilities that students should have acquired throughout their academic journey in relation to the particular program they are enrolled in. The purpose of defining POs is to ensure that students have achieved the desired learning outcomes by the time they graduate. These outcomes are aligned with the program's mission and are designed to prepare students for their future careers or further academic pursuits.

Course Outcomes

Course Outcomes (COs) are distinct statements that delineate the intended learning outcomes of a particular course. They provide a clear understanding of what learners are expected to comprehend, the skills they should acquire, the ethical principles they should adhere to, and the knowledge and behaviors they should demonstrate upon completing the course.

Assessment

Assessment is a vital process conducted by educational institutions to evaluate and measure the success of PEOs and Program Outcomes (POs). It involves the systematic identification, collection, and preparation of data that provide insights into the area to which students have met the desired learning goals.

Attainment

Attainment refers to the level of achievement or accomplishment of specific goals or standards. In an educational context, attainment often refers to the academic achievement of students, typically measured through tests, examinations, or other assessment methods. It is a measure of their competencies, proficiency and understanding in a particular subject or field.

RESEARCH METHODOLOGY

Following flowchart describes that Rubrics developed for attainment of COs and POs and validation of POs and PSOs.
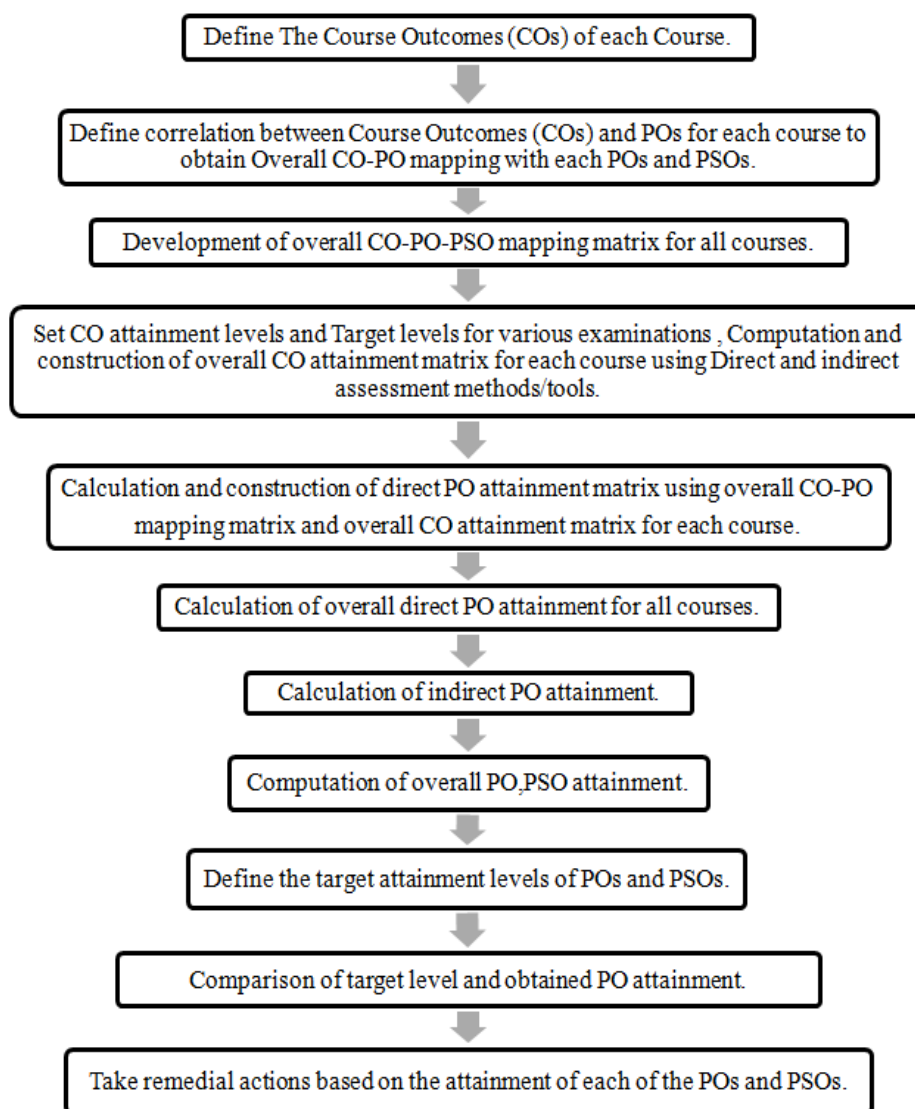

Fig 1: Rubrics developed for attainment of COs and POs

Step 1: Define The Course Outcomes (COs) Of Each Course.

Course Outcomes (COs) are essential components of Outcome-Based Education (OBE) as they specify the expected understanding, skillfulness, and abilities that students should gain upon successful completion of a course. The formulation of COs takes into account the course topics and subtopics mentioned in each chapter, and typically a course may have 5 or 6 COs. In the context of OBE implementation, the MSBTE (Maharashtra State Board of Technical Education) defines the COs for every course to fulfill the POs and other requisite. The COs are aligned with the broader goals and objectives of the program to ensure consistency and coherence in the curriculum.

Followings are the COs for the course Advanced Surveying:

CO Code	Course Outcome Statement
C22301.1	Prepare plans using Plane Table Surveys.
C22301.2	Prepare plans using Theodolite surveys.
C22301.3	Find distances and elevations using Tacheometer.
C22301.4	Set out simple circular curves.
C22301.5	Prepare plans using Total Station instrument.
C22301.6	Locate coordinates of stations using GPS.

Table 1: Course Outcome Statement for ASU (22301)

Step 2: Define correlation among COs and POs for every course to obtain comprehensive CO-PO-PSO mapping.

The procedure of CO-PO mapping and attainment in a diploma engineering program involves several steps. It begins with the formulation of correct COs for all courses throughout the program. The course outcomes (COs) are designed using action verbs of study levels recommended by Benjamin Bloom's Taxonomy and revised by Anderson and Krathwohl. Which provide clarity on the expected knowledge, skills, and behaviors of students.

Once the COs are defined, a association is fixed between COs and POs on a scale of 1 to 3. This scale indicates the level of alignment and contribution of the COs towards the attainment of the POs. A rating of 1 represents a slight or low contribution, 2 represents a moderate or medium contribution, and 3 represents a substantial or high contribution.

To compute the attainment of COs, it is crucial to map each CO to the corresponding PO. The mapping between COs and POs should be structured in a way that, where the attainment of COs directly contributes to the achievement of the associated POs.

A mapping matrix is created for all subjects in the curriculum, to establish clear connections between COs and POs.

Throughout this process, the course outcomes and their mapping with the program outcomes undergo frequent review by a committee comprising senior faculty members. This review ensures that the COs accurately align with the intended outcomes of the program and that the mapping between COs and POs is appropriate.

The mapping matrix covers all subjects in the curriculum, ensuring comprehensive coverage of the curriculum. It allows for a systematic and structured approach to aligning the learning outcomes at the course level with the desired outcomes at the program level. This alignment ensures that the attainment of COs contributes to the achievement of the POs and PSOs.

Semester-III subject and sub code: Advanced surveying (22301)									
Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2
C22301.1	3	1	-	-	-	1	2	1	2
C22301.2	3	1	-	2	-	1	3	1	2
C22301.3	3	1	-	2	-	1	2	1	2
C22301.4	3	2	-	2	-	1	3	1	2
C22301.5	3	2	2	3	-	1	3	1	2
C22301.6	3	-	-	3	-	1	2	1	2
C22301 TOTAL	18	7	2	12	-	6	15	6	12
Avg.Correlation Level	3.00	1.40	2.00	2.40	-	1.00	2.50	1.00	2.00

Table 2: CO-PO mapping matrix

Correlation levels- Slight (Low): 1, Moderate (Medium): 2, Substantial (High): 3 None: -

Step 3: Construction of comprehensive CO-PO-PSO mapping table for entire courses.

After correlating Course Outcomes (COs) with Program Outcomes (POs) for each course, the next step is to create an overall mapping matrix that encompasses all courses in the program, including both core and elective subjects, as well as the first year. This mapping matrix provides a comprehensive view of how the COs align with the broader program-level outcomes. The overall mapping matrix includes all the courses offered throughout the program, indicating the respective COs and their corresponding alignment with the POs. It allows for a holistic assessment of how each course contributes to the achievement of the desired program level outcomes.

Results of Evaluation of each Program Outcomes & Program Specific Outcomes Attainment matrix										
Sr. No	Course code	Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2
1	C22101	ENG	1.33	-	1.33	-	-	1.00	2.00	-	-
2	C22102	BSC	1.50	1.67	-	1.00	-	-	1.00	-	-
3	C22103	BMS	2.00	2.60	1.67	-	-	-	1.00	-	-
4	C22001	ICT	1.00	1.00	2.00	2.25	-	1.00	1.25	-	-
5	C22002	EGM	1.67	1.50	2.00	1.40	-	-	1.00	2.00	-
6	C22004	WPM	-	1.50	1.33	3.00	-	-	-	1.00	-
7	C22201	AMS	1.00	1.40	-	2.25	-	-	2.60	1.00	-
8	C22202	ASM	1.00	1.83	-	1.83	1.66	-	1.00	1..33	2.00
9	C22203	AME	1.50	1.33	1.33	1.17	1.17	1.00	1.00	1.00	1.00
10	C22204	CMA	2.00	1.67	1.50	1.00	1.33	-	1.00	1.00	1.00
11	C22205	BSU	2.67	2.00	1.67	2.50	2.67	—	1.67	1.17	1.17
12	C22008	CEW	1.40	1.60	2.60	2.40	1.80	1.40	1.00	2.00	2.40
13	C22009	BCC	-	-	1.00	-	-	3.00	2.00	1.00	-
14	C22301	ASU	3.00	1.40	2.00	2.40	-	1.00	2.50	1.00	2.00
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40	C22032	EDP	1.00	1.00	1.00	1.00	1.00	1.20	1.80	1.00	1.00

Table 3: Gross/overall CO-PO mapping table of the entire subject

Step 4: Set CO attainment levels and Target levels for various examinations, Calculation and formation of gross/overall CO attainment table for every subject by use of Direct and indirect assessment methods.

Attainment refers to measuring the achievement of COs through the assessment of students' knowledge and skills based on their performance. This can be done using various assessment instruments such as internal assessments, PR-PA, TH-PA , and final examinations (ESE). These methods directly evaluate what students abilities, providing concrete proof of their learning. By utilizing direct attainment methods, educators can gain insights into the extent to which students have acquired the intended knowledge and skills outlined in the COs. These assessments serve as a representative sample of student learning, offering robust evidence of their educational achievements. The results obtained from direct attainment measures can be used to evaluate the effectiveness of teaching strategies, curriculum design, and instructional materials. On the other hand, indirect methods of measuring attainment, like Course Exit Surveys, involve gathering students' reflections on their learning experiences. These surveys typically ask students to provide their opinions and thoughts about the knowledge and skills they believe they have acquired during the course. Indirect measures focus on students' perceptions of their learning and how they value the acquired knowledge and skills. They provide valuable insights into students' self assessment and their perspectives on the educational outcomes.

Assessment Process for CO Attainment:

Rubrics are commonly used tools for the evaluation and assessment of Course Outcomes and Program Outcomes. The performance of students is assessed based on internal evaluation and the end semester examination. Internal assessments contribute 20% to the total attainment of a CO, while the End Semester Examination contributes 80%. After measuring course outcomes (CO) attainment for a course, the CO to PO mapping matrix provides a framework to assess the alignment between COs and the broader POs of a program.
There are various methods for assessment.
Direct and Indirect methods for attainment of COs .

Methods / Tools	Category
CO Attainment of all courses through Board Assessment (ESE-TH,ESE-OR/PR) (80%) and Internal assessment (TH-PA,PR-PA) (20%)	Direct Assessment (80%)
PO/PSO Survey, feedback of Respective pass out batch and Course exit surveys.	Indirect Assessment (20%)

Table 4: Tools for direct and indirect attainment of COs

External & Internal Examination Assessment Process:
Rubrics: Program set/defined attainment level and target levels for various examinations based on the following benchmark points.
Firstly the learning level of students is understood properly and detailed discussion made, and the target level is set by the associated faculty member who teaching the course.
Common target level is recognized for all the COs of a course and it is commonly decided by the all faculty members.
Target levels are approximately the same for all courses because Students are coming from vernacular medium.
The target level parameters are "Board TSI, Average of TH-PA, 60% of PR-ESE, 60% of PR-PA".
Therefore Targets are quantized into certain 0-3 levels , 3 is the highest number for levels and it is given as below:
1.Program set/defined attainment level and Target level for Board Theory Examinations (ESE) are as below:

Attainment Level	Target Level
Attainment level - 0	Students scored below 40% of the Board (TSI*) percentage marks.
Attainment level - 1	40% and above students scored equal and above Board (TSI*) percentage marks.
Attainment level - 2	50% and above students scored equal and above Board (TSI*) percentage marks.
Attainment level - 3	60 % and above students scored equal and above Board (TSI*) percentage marks.

*TSI-Theory score index (Provided by MSBTE)

Table 5 : set/defined attainment level and target level (for TH-ESE)

2.Program set/defined attainment level and Target level for PR/OR (60% marks) ,TW(60% marks), TH-PA Tests (Average marks) Exams are below:

Attainment Level	Target Level
Attainment level - 0	Students scored below 40% of the Average /60% mark.
Attainment level - 1	40% and above students scored equal and above average /60% mark.
Attainment level - 2	50% and above students scored equal and above average /60% mark.
Attainment level - 3	60 % and above students scored equal and above average /60% mark.

Table 6 : set/defined attainment level and target level (for PR,TW,TH-PA)

The total attainment of CO is computed by considering 80% of external evaluation and 20% internal evaluation and it is combined and converted again to 80% and then 20% course exit survey results are added. The final CO attainment for the course is computed by considering the mean of all CO's total attainment count. After measuring Course Outcomes attainment for a subject, the CO-PO mapping matrix provides program outcome (PO) attainment levels.

CE-3I	Mapped COs				Indirect Attainment (20%)
	Direct Attainment (80%)				
22301-ASU	Board Assessment (80%)		Internal Assessment (20%)		Course Exit Survey
Tested COs	ESE/TH	ESE/PR	TH PA	PR PA	
C22301.1	✓	✓	✓	✓	✓
C22301.2	✓	✓	✓	✓	✓
C22301.3	✓	✓	✓	✓	✓
C22301.4	✓	✓	✓	✓	✓
C22301.5	✓	✓	✓	✓	✓
C22301.6	✓	✓	✓	✓	✓

Mark ✓ Where CO's are Tested   **Table 7:** Mapping of COs

CE-3I	Direct Attainment (80%)						Indirect Attainment (20%)	Total Attainment
22301-ASU	Board Assessment (80%)			Internal Assessment (20%)			Course Exit Survey (iii)	0.8(0.8(i)+0.2(ii))+ 0.2(iii)
Tested COs	ESE/TH	ESE/PR	AVERAGE (i)	TH PA	PR PA	AVERAGE (ii)		
C22301.1	2	3	2.5	3	3	3	2.11	2.50
C22301.2	2	3	2.5	3	3	3	2.23	2.53
C22301.3	2	3	2.5	3	3	3	2.00	2.48
C22301.4	2	3	2.5	3	3	3	2.12	2.50
C22301.5	2	3	2.5	3	3	3	2.02	2.48
C22301.6	2	3	2.5	3	3	3	1.91	2.46
AVERAGE	2.00	3.00	2.50	3.00	3.00	3.00	2.06	2.49

Table 8: Total attainment of COs

Step 5 : Computation and constructing of direct Program Outcome (PO) attainment matrix using Gross CO-PO mapping matrix and total CO attainment matrix for each course.

Based on the total CO attainment and the mapping of each CO with Program Outcomes (POs) and Program Specific Outcomes (PSOs), the ultimate attainment of Program Outcomes and Program Specific Outcomes can be calculated using the below formula and it is shown as in the following table.

PO Direct Attainment = (Corresponding Avg.cell value i.e. CO-PO Mapping) x Overall CO attainment Value) / 3

Semester-III subject and sub code: Advanced surveying (22301) (Result Based)								
PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO 1	PSO 2
PO Attainment	2.49	1.16	1.66	1.99	-	0.83	2.08	0.83	1.66

Table 9: Direct PO attainment result

Step 6 : Computation of Gross/overall direct Program Outcome attainment for all courses.

The direct assessment tools are used to calculate the achievement of each Program Outcome (PO) and Program Specific Outcome (PSO) by taking the cumulative average of all the courses that contribute to each PO and PSO. The direct PO,PSO attainment is given 80% weightage.

Results of Evaluation of each Program Outcomes & Program Specific Outcomes Attainment matrix										
Sr. No	Course code	Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2
1	C22101	ENG	1.11	-	1.11	-	-	0.83	1.66	-	-
2	C22102	BSC	1.08	1.20	-	0.72	-	-	0.72	-	-
3	C22103	BMS	0.59	0.77	0.49	-	-	-	0.30	-	-
4	C22001	ICT	0.93	0.93	1.86	2.09	-	0.93	1.16	-	-
5	C22002	EGM	1.56	1.41	1.87	1.31	-	-	0.94	1.87	-
6	C22004	WPM	-	1.09	0.96	2.17	-	-	-	0.72	-

7	C22201	AMS	0.72	1.01	-	1.63	-	-	1.88	0.72	-
8	C22202	ASM	0.89	1.63	-	1.63	1.47	-	0.89	1.18	1.77
9	C22203	AME	1.37	1.22	1.22	1.07	1.07	0.91	0.91	0.91	0.91
10	C22204	CMA	1.83	1.52	1.37	0.91	1.22	-	0.91	0.91	0.91
11	C22205	BSU	2.44	1.83	1.52	2.28	2.44	—	1.52	1.07	1.07
12	C22008	CEW	1.32	1.50	2.44	2.26	1.69	1.32	0.94	1.88	2.26
13	C22009	BCC	-	-	0.94	-	-	2.82	1.88	0.94	-
14	C22301	ASU	2.49	1.16	1.66	1.99	-	0.83	2.08	0.83	1.66
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40	C22032	EDP	0.93	0.93	0.93	0.93	0.93	1.12	1.68	0.93	0.93
TOTAL SUM			45.51	38.08	39.23	37.35	28.05	32.35	46.65	34.97	34.86
Direct PO Attainment			1.20	1.15	1.27	1.25	1.12	1.08	1.23	1.03	1.16
80% direct PO Attainment			0.96	0.92	1.01	1.00	0.90	0.86	0.98	0.82	0.93

Table 10: Comprehensive direct Program Outcomes attainment for all courses.

Step 7: Computation of indirect Program Outcomes attainment.
Indirect Assessment Methods:

Based on the provided information, the indirect attainment of each Program Outcome (PO) and Program Specific Outcome (PSO) is calculated by using indirect assessment tools like exit survey forms and student portfolios. The Program Exit surveys are collected from the 3rd year students upon successful end of their diploma program. The Program Exit survey serves as a comprehensive feedback mechanism for assessing PO/PSO attainment through the indirect assessment method. It contributes 20% of the total survey report

PO,PSO	PO1	PO 2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2
Indirect Attainment	2.04	1.94	2.17	2.13	1.94	2.02	1.85	2.00	2.02
20% Indirect Attainment	0.41	0.39	0.43	0.43	0.39	0.40	0.37	0.40	0.40

Table 11: Computation of indirect Program Outcomes attainment.

Step 8: Calculation of overall Program Outcome (PO) and Program Specific Outcome (PSO) attainment.

The final PO and PSO attainment is calculated using a weighted approach, considering both the direct method and indirect method of assessment. The weights assigned to each method are 80% for the direct method and 20% for the indirect method. Overall PO,PSO attainment matrix is prepared based on direct and indirect PO,PSO attainment. After calculating direct PO,PSO attainment and indirect PO,PSO attainment for all courses, a overall PO,PSO attainment matrix is prepared by combining the direct and indirect PO,PSO attainment using the following formula:

Total PO Attainment = 0.8 x (Direct PO Attainment) + 0.2 x (Indirect PO attainment)

Total PSO attainment = 0.8 x (Direct PSO Attainment) + 0.2 x (Indirect PSO Attainment)

Results of Evaluation of each Program Outcomes & Program Specific Outcomes Attainment matrix										
Sr. No	Course code	COURSE	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2
1	C22101	ENG	1.11	-	1.11	-	-	0.83	1.66	-	-
2	C22102	BSC	1.08	1.20	-	0.72	-	-	0.72	-	-
3	C22103	BMS	0.59	0.77	0.49	-	-	-	0.30	-	-
4	C22001	ICT	0.93	0.93	1.86	2.09	-	0.93	1.16	-	-
5	C22002	EGM	1.56	1.41	1.87	1.31	-	-	0.94	1.87	-
6	C22004	WPM	-	1.09	0.96	2.17	-	-	-	0.72	-
7	C22201	AMS	0.72	1.01	-	1.63	-	-	1.88	0.72	-
8	C22202	ASM	0.89	1.63	-	1.63	1.47	-	0.89	1.18	1.77
9	C22203	AME	1.37	1.22	1.22	1.07	1.07	0.91	0.91	0.91	0.91
10	C22204	CMA	1.83	1.52	1.37	0.91	1.22	-	0.91	0.91	0.91
11	C22205	BSU	2.44	1.83	1.52	2.28	2.44	—	1.52	1.07	1.07
12	C22008	CEW	1.32	1.50	2.44	2.26	1.69	1.32	0.94	1.88	2.26
13	C22009	BCC	-	-	0.94	-	-	2.82	1.88	0.94	-
14	C22301	ASU	2.49	1.16	1.66	1.99	-	0.83	2.08	0.83	1.66
.	.	.	.	.	.	.	.	.	.	.	.
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40	C22032	EDP	0.93	0.93	0.93	0.93	0.93	1.12	1.68	0.93	0.93
TOTAL SUM			45.51	38.08	39.23	37.35	28.05	32.35	46.65	34.97	34.86
Direct PO Attainment			1.20	1.15	1.27	1.25	1.12	1.08	1.23	1.03	1.16
80% direct PO Attainment (i)			0.96	0.92	1.01	1.00	0.90	0.86	0.98	0.82	0.93
Indirect Attainment			2.04	1.94	2.17	2.13	1.94	2.02	1.85	2.00	2.02
20% Indirect PO Attainment (ii)			0.41	0.39	0.43	0.43	0.39	0.40	0.37	0.40	0.40
Total PO attainment =(i)+(ii)			1.37	1.31	1.45	1.42	1.28	1.27	1.35	1.22	1.33
PO Target level			1.33	1.30	1.43	1.31	1.29	1.18	1.39	1.10	1.29

Table 12: Computation of overall PO,PSO attainment.

Step 9: Define the Target Attainment levels of POs and PSOs.

After completing the CO to PO mapping for all courses, the next step is to analyze the cumulative average of the mapping for each PO and Program Specific Outcome (PSO). Based on this analysis, attainment targets are set for each PO and PSO, typically at 80% of the cumulative average is taken.

By setting attainment targets at 80% of the cumulative average, there is an actual expectation that students will achieve a substantial level of mastery in the intended program outcomes. This target provides a benchmark for assessing the overall effectiveness of the curriculum and the extent to which students are meeting the desired program-level outcomes.

Sr. No	Course code	Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2
Results of Course CO-PO & PSO Mapping											
1	C22101	ENG	1.33	-	1.33	-	-	1.00	2.00	-	-
2	C22102	BSC	1.50	1.67	-	1.00	-	-	1.00	-	-
3	C22103	BMS	2.00	2.60	1.67	-	-	-	1.00	-	-
4	C22001	ICT	1.00	1.00	2.00	2.25	-	1.00	1.25	-	-
5	C22002	EGM	1.67	1.50	2.00	1.40	-	-	1.00	2.00	-
6	C22004	WPM	-	1.50	1.33	3.00	-	-	-	1.00	-
7	C22201	AMS	1.00	1.40	-	2.25	-	-	2.60	1.00	-
8	C22202	ASM	1.00	1.83	-	1.83	1.66	-	1.00	1..33	2.00
9	C22203	AME	1.50	1.33	1.33	1.17	1.17	1.00	1.00	1.00	1.00
10	C22204	CMA	2.00	1.67	1.50	1.00	1.33	-	1.00	1.00	1.00
11	C22205	BSU	2.67	2.00	1.67	2.50	2.67	—	1.67	1.17	1.17
12	C22008	CEW	1.40	1.60	2.60	2.40	1.80	1.40	1.00	2.00	2.40
13	C22009	BCC	-	-	1.00	-	-	3.00	2.00	1.00	-
14	C22301	ASU	3.00	1.40	2.00	2.40	-	1.00	2.50	1.00	2.00
.	.	.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.	.	.
40	C22032	EDP	1.00	1.00	1.00	1.00	1.00	1.20	1.80	1.00	1.00
Total SUM			63.29	53.82	55.53	49.24	40.38	44.30	66.16	45.26	48.23
Avg.			1.67	1.63	1.79	1.64	1.62	1.48	1.74	1.37	1.61
PO Target level = 0.80*(Avg.)			1.33	1.30	1.43	1.31	1.29	1.18	1.39	1.10	1.29

Table 13: Target attainment levels of POs and PSOs.

Step 10: The comparison of the target level and obtained PO (Program Outcome) attainment

Once the attainment targets are set for each Program Outcome (PO) and Program Specific Outcome (PSO), the obtained values are compared with these targets. If the attainment targets for POs and PSOs are achieved, the same process continues for subsequent batches. If the targets are not achieved, continuous improvement actions are taken to address the identified areas of improvement. This iterative process allows for ongoing enhancement of the curriculum, instruction, and assessment practices to improve student learning outcomes.

PO	PO.1	PO.2	PO.3	PO.4	PO.5	PO.6	PO.7	PSO.1	PSO.2
Attainment Levels	1.37	1.31	1.45	1.42	1.28	1.27	1.35	1.22	1.33
Target levels	1.33	1.30	1.43	1.31	1.29	1.18	1.39	1.10	1.29

Table 14: The comparison of the target level and obtained PO (Program Outcome) attainment

Step 11: Take remedial actions based on the attainment of each of the Program outcomes and Program Specific outcomes.

The purpose of taking continuous improvement actions is to address the identified gaps or weaknesses and enhance the attainment of the intended outcomes. These actions are aimed at improving the teaching and learning processes, assessment methods, or any other factors that may contribute to the desired outcomes. By implementing continuous improvement actions, educational institutions strive to bridge the gap between the current attainment levels and the set targets. Regular monitoring, analysis, and adjustment of instructional practices help ensure ongoing progress and improvement in meeting the desired program outcomes.

Distribution of Weight

The Advanced Surveying (ASU) course consists of 4 heads, i.e., Theory- End SEM Examination (TH-ESE) & Term Test (TH-PA), practical (PR)- External Practical (PR-ESE) & Term work (PR-PA). The assessment methods used in this course are typically grouped into following two main categories:
 (1) Internal Assessment (IA) – It includes Term Test (TH-PA) and Term work (PR-PA) (20%)
(2) External Assessment (EA) – It includes Theory End SEM Examination (TH-ESE) & External Practical (PR-ESE) (80%)
In the Advanced Surveying (ASU) course, the assessment of student performance is divided into two categories: Internal Assessment (IA) and External Assessment (EA), the internal assessment contributes 20% of the total marks and external assessment contributes 80% of the total marks.

Assessment Pattern

The marks which are assigned in MSBTE curriculum for ASU course are as below:
TH-ESE- 70 Marks, PR-ESE-50 marks, TH-PA-30 marks and TH-PA – 50 marks .

Course File

The program (department) maintains a course file for each respective course to facilitate the calculation of COs and POs attainment. The Course file typically includes various components that aid in the assessment and evaluation process. The Course file serves as a repository of information and evidence for assessing student learning, evaluating the effectiveness of the course, and ensuring alignment with the program's goals and objectives. It provides a comprehensive record of the teaching and learning process, enabling continuous improvement and quality assurance in the delivery of the course and the program as a whole. It includes following components:

- Index (Basic information and all contents in the Course File)
- Vision, mission, objectives
- CO, PO, PSO, PEO.
- Academic calendars
- Timetable, Teaching scheme, Examination scheme
- Syllabus copy, Teaching plan, Lab plan
- Students list (with roll call /Enrollment number)
- CO-PO-PSO Mapping matrices
- UT-I, UT-II and Micro-project marks entry with CO attainment.
- Assignments / MCQ's/previous board question papers /Model Answers
- MSBTE results which includes – Theory (TH) + Practical / Oral (PR-ESE) + Term work (TW) + Term Test (TH-PA) etc.
- Details of Reference books, learning resources ,links.
- Course Exit survey form and analysis.
- Summary of all attainment.
- Attendance record, record of Lab experiments conduction.

Continuous Evaluation

As per the National Board of Accreditation (NBA) guidelines, continuous assessment is a qualitative process that involves regularly evaluating student's progress and learning outcomes throughout the duration of a course or program. The assessment process in continuous evaluation typically follows these steps:

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

RESULTS AND DISCUSSION OF EVALUATION OF PROGRAMME

Following graph shows the PO and PSO Total Attainment with attainment levels and target levels.

PO and PSO Total Attainment (A.Y.2021-22)

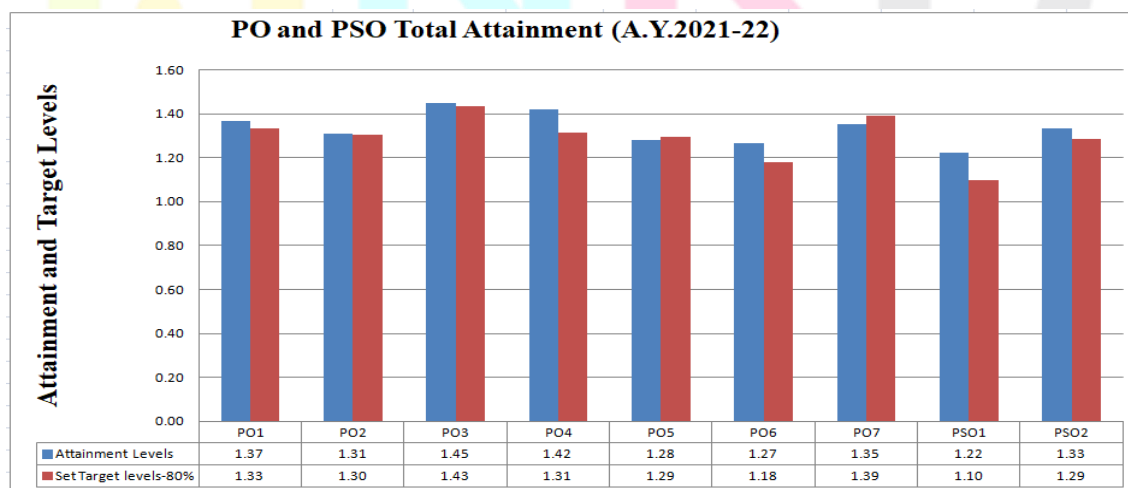|	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2
Attainment Levels	1.37	1.31	1.45	1.42	1.28	1.27	1.35	1.22	1.33
Set Target levels-80%	1.33	1.30	1.43	1.31	1.29	1.18	1.39	1.10	1.29

Fig 2: PO and PSO Total attainment with attainment levels and target levels.

For the measurement and evaluation process, the course Advanced Surveying in the Diploma Civil Engineering program has been selected as the focal point. Most of the POs and PSOs have achieved the target levels, highlighting the positive outcomes of the program. However, PO5 and PO7 have been identified as weaker program outcomes, necessitating revision corrective

actions are taken in the upcoming academic year. This attainment process of POs and PSOs contributes significantly to the improvement of the curriculum and the overall teaching-learning process.

Conclusion

The evaluation and assessment of COs and POs involve the collection and utilization of student learning data to drive improvement. The aforementioned study presents an effective approach utilizing a spreadsheet to measure and evaluate the outcomes of a course. By leveraging the final theory exam results declared by MSBTE (Maharashtra State Board of Technical Education), immediate insights can be obtained regarding CO attainment, identification of gaps in COs, and the formulation of corrective actions to address these gaps. Criterion 3 of NBA's accreditation criteria plays a key role in evaluating criterion 7. The results obtained for POs and Program Specific Outcomes (PSOs), derived through this approach, can be compared against the target levels. Identified weaknesses in POs and PSOs, where the results fall below the target values, can be addressed through appropriate action plans in the subsequent academic year.

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