



# A Study On Course Outcome Attainments, And Assessments In Object Based Education

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**Abstract:** As the need to make our engineering graduates marketable and competitive on a global scale grows, so does the significance of outcome-based education (OBE). Objective-based education (OBE) is a paradigm that proposes centering an entire educational system around a set of measurable objectives (outcomes). It is reasonable to anticipate that by the time a student has graduated, he or she will have accomplished the fundamental goal of education, which is to acquire the skills essential to find gainful employment in the field in which he or she has shown an aptitude or interest. The effectiveness of OBE depends on regularly evaluating progress toward objectives and making adjustments in light of that input, making evaluation a crucial aspect of the OBE. In practice, however, the idea of OBE led to varying degrees of achievement of the Programme Outcome (PO) depending on the Course Outcome (CO). Since the CO for each evaluation might be linked to more than one PO, carrying out the OBE could be difficult.

This study examines outcome-based education and accomplishments. The significance of the Course Outcomes in relation to the evaluation of the Program Outcomes and the Education Objectives of the Program. The technique for evaluating the outcomes of the course, in addition to the direct evaluation and indirect assessment instruments, along with some sample values. Staff members use the results of achieving Course Outcomes to achieve both Program and Program Educational Objectives, and to enhance the quality of instruction as a whole. The degree of achievement may also be readily adjusted depending on the difficulty of the course as well as the amount of success achieved by the student. Consequently, this sort of application will aid faculty in reducing the effort associated with each course.

**Index Terms** - Outcome based education, Course outcome, Program outcome, Assessment, Attainment

## I. INTRODUCTION

The National Board of Accreditation (NBA) in India has started implementing Outcome Based Education even though the country has only recently ratified the Washington Accord (OBE). Standards and procedures for accreditation are detailed on the NBA's website[1]. To be called a global engineer in the present day, it is necessary for a graduate engineer to have experience working in international contexts. An engineer has a better chance of succeeding if he was educated in an OBE environment, and currently, as a result of regulations implemented by the government and guidelines provided by the NBA, practically all professional schools have begun using OBE.

In most cases, students are still required to take classes; but, according to OBE, students' achievements are evaluated based on the abilities they have learned. As a consequence of this, several educational establishments in the nations of the signatories that provide degrees in Engineering have been struggling with the implementation of OBE. Figure 1 illustrates the organisational structure that is most often used when OBE is being put into practise. As can be seen in Figure 1, this model is broken down into two distinct stages: the stage of design, and the stage of evaluation. The design step is top-down, whereby the programme educational goals are utilised to establish the programme outcomes (PO), which will then drive the course outcomes (CO). However, the accrediting organisation requires that the programme meet a certain number of general outcomes in order to maintain its accreditation. The assessment stage is a bottom-up process, in which the evaluation of

the results of individual courses is utilised to evaluate whether or not the program's objectives have been met. The primary challenge presented by this approach is determining how to establish a connection between the outcomes of individual courses and those of the overall programme in such a way that successful completion of a individual course objectives will ensure successful completion of the programme outcomes.

The implementation of OBE is meant to guarantee that the curriculum design satisfies the programme result as well as the programme education goal, both of which should represent the college's success in achieving its purpose and vision. The idea behind OBE is to create the curriculum in such a way that it is based on what the learner is anticipated to have accomplished by the conclusion of the education programme [2][3]. The majority of India's educational institutions that provide engineering-related coursework have voiced their approval of the move in the direction of OBE adoption [4]. Many other educational methods have been brought to light as supporting evidence for the OBE's adoption [5]. The focus of OBE is on being able to meet the human capital demands of the industry, which are determined by the input gathered from the various stakeholders.

Additionally, the meaning of OBE is interpreted differently by various academic institutions. It is common practise to see the OBE deployment as a compliance-driven endeavour rather than a performance-driven activity. On paper, the execution seems to have a high level of organisation; yet, the implementation may require a challenging data gathering procedure, that resulted in academic staff being uninterested in helping ensure OBE's success. Program Outcome (PO) and Programme Education Objective (PEO) discrepancies may arise from the course coordinator's lack of familiarity with one or more of the means by which the PEO or PO may be attained. When it comes to assessing the proportion of goals that have been accomplished, there is no consensus or shared understanding. Some people may just evaluate students' performance in the course based on their final examinations, other others would only examine certain questions in the assessment, while still others might look at all of the evaluations [6].

In addition, the implementation of OBE could not be a simple task since Course Outcome (CO) to Program Outcome (PO) mapping may not always result in a 1:1 correspondence. The accomplishment calculations have gotten more intricate as a result of the possibility that one CO is linked to multiple PO [7]. The final step is to ensure that the course results correspond to the programme outcomes. In the modern education plan, practical exercises in the laboratory are regarded as an essential component of efficient education. Thus, the total amount of teaching is divided between classroom instruction and laboratory sessions. In the laboratory, great effort is made to ensure that the theoretical instruction that is emphasised in the classroom is carried over. As a result, a combined approach is the kind of evaluation that should be used for classes like these that include a substantial amount of practical work. In this context, in addition to the evaluation that is done in the form of quizzes and tests, the students are assigned experiments to carry out in order to accomplish the goal. In addition to that, viva questions aimed at verifying the notion of comprehending accomplishment are asked of them. These evaluation techniques are referred to as one of four categories for integrated courses, with a laboratory journal serving as an additional category [8].

Due to the varied assessment measures, the true faults with the curriculum's structure could not be highlighted. The OBE categorises measurements into two basic categories: direct measurements and indirect measurements, sometimes known as separated measurements. Direct measures offer a significant benefit than separated measures since they enable us to focus on the material that pupils have learned, as well as the information that they have not perfected. The strengths of the departments might be highlighted with the use of this information. In the event that flaws are discovered, the faculty may investigate the reasons, which are within their control, and suggest potential solutions. Nevertheless, there are flaws in both types of measurements. The results of direct assessments will not shed any light on the reasons why a student has learnt something or why they have not learned anything. Measurements that are taken indirectly are reliant on perceptions, which might be very subjective. The use of both quantitative and qualitative metrics is essential when conducting an evaluation of a programme or department. In addition, it might lead to major discrepancies that have an impact on the actual completion of the course. Felder et al. [9] has identified the several measurements that may be used to examine the various criteria of POs and PEOs. The majority of these metrics, on the other hand, are based on formative assessment. As a result, the purpose of this work is to investigate the many different approaches of assessing the accomplishment of CO, all of which should reflect the accomplishment of PO.

In general, the techniques for assessing the results of programmes may be broken down into More Or Less Obvious Steps Direct methods typically rely on tangible outcomes like test scores or project grades, while indirect methods mine respondents' thoughts and opinions through techniques like surveys and focus groups. Alternately, there are two distinct kinds of evaluations that might be carried out by an educational programme. The first one is concerned with the efficiency of the programme, and the second one is concerned with the capabilities of those who have graduated from the programme [10].



Fig. 1. Overview of OBE Implementation

The program specific outcome, also known as the PSO, is a set of statements that characterise the level of expertise attained by the graduate in a manner that is distinctive to the programme of study. For the Computer Engineering Undergraduate programme, for instance, one of the PSOs may be "Developed software application to tackle real world issue." Direct assessment methods and indirect assessment methods are the two main categories of evaluation strategies.

The Direct Approach shows off the student's skills and knowledge through various means, such as tests given throughout the semester, a final exam, a presentation, and in-class work. These methods offer concrete evidence of student learning because they depict what students know and/or are capable of doing[11].

The Indirect Method provides information regarding how graduates perceive their own learning as well as how various stakeholders value the knowledge that graduates have gained. An example of one of the techniques used for indirect assessment is the course evaluation survey. All of an instructor's assessment data, including quizzes, lab reports, assignments, final projects, and exams, has been imported into a standardised course as well as programme outcome (CO-PO) assessment template. The software streamlines the process of evaluating courses and instructors and creating grading rubrics, and it helps teachers weigh the pros and cons of their students' progress toward meeting course and programme goals so they can improve their teaching accordingly.

## II. BACKGROUND STUDY

Outcome-Based Education (OBE), a paradigm developed by the Washington Accord, is being implemented in academic institutions throughout India [1]. These days, a significant number of countries in South Asia and the Pacific are moving toward an OBE paradigm [12][13]. Using outcome-based predictive analysis, S.K.Bindra et al. have proposed a method to produce question papers [14]. The process of education at the university of Iran has been automated, and an outcome-based education system has been established. This has increased the institution's flexibility and made the process more manageable [15]. The OBE model has been used by T. V. Reddy et al. for the purpose of assessing the quality of projects [16]. [17] The researchers explored the role that information and communications technology plays in accomplishing the attainments of Outcome-Based Education. The researchers had a discussion on how outcome-based education may be applied at the engineering level [18][19]. In the context of education for civil engineering, El-Maaddawy advocated outcome-based learning. In order to improve the quality of education provided to high school and college students alike, they implemented outcome based learning in a variety of elective and required courses [20]. Rajak et al. spoke about the many ways to compute attainments for postgraduate programmes. They discussed the procedure, which begins with the establishment of both course and programme outcomes and concludes with the successful completion of the program's educational objectives and the achievement of its stated outcomes. This procedure starts with the establishment of both course and programme goals [21]. The researchers Tiwari et al. highlighted how a disconnect between education and industry has led to increased rates of unemployment among engineering graduates. They developed a new curriculum that was focused on the requirements of the industry in order to close that gap and build a stronger link between conventional engineering education and education based on outcomes [22]. In their article, Rajak et al. talk about automating outcome-based education by focusing on the completion of various course and programme objectives. They carry out a comparison research based on the accomplishments of the most recent three batches of MCA students to graduate from the programme. The evaluation of the HVE course was carried out by Bassi et al. They conducted an investigation into the pupils whose goals were not accomplished. Calculations were done with the assistance of Microsoft Excel [23]. Terang et al. addressed the process of attainment, zeroing in on the selection of low-achieving students in EEC-II. Stakeholders' understanding of the OBE process is tested to see how well they understood it [24]. Chandna et al. provided a summary of the approach for the evaluation of the

outcomes of the course by assessing the attainments of individual students in comparison to specified objectives [25]. In their study, Roy et al. analysed the connections between the course result of the subject Power Quality and the programme outcomes. Internal marks, assignments, and tutorials are the three components that make up this evaluation [26]. A curriculum or course plan may be constructed using the framework that Bansal et al. mentioned, which also includes assessment procedures. Tshai et al. brought attention to the formulation of PEO in conjunction with many stakeholders. The author also provided the measures that may be used to enhance programme educational goals in the event that poor attainments are achieved [27].

### III. EVALUATION OF COURSE OUTCOMES

Course outcomes are more detailed descriptions of what learners should have accomplished by the end of a given unit of study [28]. The phrases "specific knowledge," "practical skills," "areas of professional development," "attitude," and "higher-order thinking abilities," among others, are what are referred to as "expected course outcome statements," and they describe what faculty members anticipate their students will acquire, learn, or master as a result of taking a particular course. Following that step, Learning outcomes from courses are mapped to curriculum goals [1].

The vision, mission, and programme education objectives are covered in criterion I of the NBA accreditation manual; programme outcomes are covered in criterion II; and course outcomes are covered in criterion III of the programme curriculum. The amount of completed POs is used as one of the inputs in calculating PEO attainment. The completion of C-Os is also factored into the final calculation of P-Os. So, CO is a major factor in getting accredited.

To better understand the interplay between PEOs, POs, and Cos, consider the following diagram.

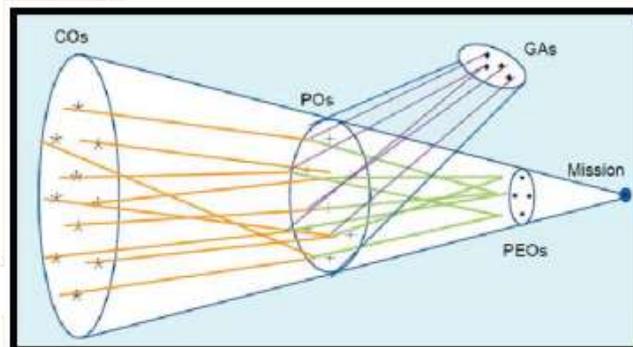


Fig. 2. Correlation Between PEOs, Pos, and Cos

The course outcomes are a few assertions about a specific course that have been developed by a subject expert. These statements are then presented to a variety of stakeholders, and the board of studies of a programme then gives their approval to the statements. It is possible to get a postgraduate degree or an undergraduate degree via the programme [29]. Table I presents the learning objectives that were covered in the topic of "Computer Concepts and Principles of Programming."

TABLE I: COURSE OUTCOME OF SUBJECT "COMPUTER CONCEPTS &amp; PRINCIPLES OF PROGRAMMING"

CO1	The idea of programming languages, along with the development of a flowchart and algorithm, for the purpose of solving a problem.
CO2	Utilization of data structures like arrays, modules, loops, conditionals, and records.
CO3	Conversions between computer units, the computer's numbering system, the computer's operations, and the computer's operational units.
CO4	the concept of an operating system, as well as the many different approaches to computing.
CO5	Abstraction, encapsulation, inheritance, polymorphism, static and dynamic scope, recursion, and the other OOP principles.

### 3.1 Course Outcomes Assessment

Assessment is a method used by academic institutions to determine the level of quality of the courses and programmes they provide, leading to the achievement of the accredited status. Because OBE is a closed loop system, assessment is an essential component of the certification process and it is of the utmost importance in OBE. Assessment not only provides useful information for redefining course goals but also for rethinking how teaching and grading strategies should be implemented.

The current assessment of students' progress in engineering education is largely centred on how well they do on the course's culminating test; however, in light of OBE, it is necessary to evaluate students' progress in all aspects of their education. In addition to adding a greater number of assessment tools like assignments, mini projects, and so on, Exams should be set up in a way that allows them to assess whether or not students have achieved the course's intended outcomes. Both the direct and indirect methods of gauging student progress will be covered in upcoming lectures. Each student's academic performance in the class as a whole is taken into account in the direct evaluation tool. In contrast, in the indirect evaluation system, results from the course are measured by means of surveys and rubrics.

PEOs are evaluated after three to four years after graduation, and in most cases, indirect tools account for 70–80% of the total score, while direct tools contribute 20–30%. The POs are evaluated at the end of the course, and in most cases, indirect tools contribute 50–60% of the total score, while direct tools contribute 40–50%. On the other hand, the COs are evaluated at the end of the course, and in most cases, indirect tools contribute 20–30% of the total score, and direct tools contribute 70–80%. This information is summarised in table II, which is shown below.

Table II.: CO-PO Matrix for ELX304

Sr. No.	Item	Assessment Done	PO <sub>3</sub>	PO <sub>4</sub>
			Direct Assessment	Indirect Assessment
1.	PEO	After 3-4 years of graduation	20-30%	40-50%
2.	PO	At the end of graduation	40-50%	50-60%
3.	CO	At the end of course	40-50%	20-30%

Direct and indirect methods, such as oral as well as practical exams, theoretical examinations, unit tests, assignments, as well as mini-projects, are used to evaluate students' progress toward course goals. It is important to keep in mind that since there are a variety of instruments used for evaluation, the faculty members are obligated to provide a weighting to each tool. It is necessary to determine the average evaluation of each CO by adding the appropriate tool weights to the marks that each student has acquired. After taking into account the proportion of the allocated tool that is devoted to each direct and indirect tool, the next step in the calculation of the total CO achievement is to add the direct assessment and the indirect assessment. The procedure is quite tedious and requires a significant amount of time. For the purpose of computing CO attainment, it is recommended to make use of a spreadsheet such as Microsoft Excel.

### 3.2 Course Outcomes Assessment Procedure

After the January 2013 format change that was implemented by the NBA, our institution began aggressively using the OBE technique into its teaching and learning process. As opposed to just concentrating on "output," the OBE places a greater emphasis on "outcomes," which are both predetermined and quantifiable. All of the staff members participated in a series of orientation seminars in order to get an awareness of the new NBA structure, the OBE methodology, also, CO building and assessment. Employees were instructed to consult PEOs and POs within their own units to formulate COs for their respective subject areas. In addition to that, it was expected of the staff members that they determine the assessment tools that were used for each CO. After confirming that the COs were accurate and that they correctly mapped to the POs, the domain coordinator gave his approval to the COs.

Staff members mapped courses to COs and developed the curriculum, which may consist of anything from lectures to labs to group projects to expert talks to field trips. The class was run according to this schedule, and ongoing assessments were carried out using the assessment methods that had been decided upon in advance during the whole of the semester.

Both direct and indirect technologies were used throughout the CO attainment calculation process. Direct tools were advised to contribute at a rate of 80 percent by our organisation, with indirect tools accounting for the remaining 20 percent [1].

#### 3.2.1 Direct Assessment

A direct technique of CO assessment is one in which the overall academic achievement of all of the students enrolled in a certain class is taken into consideration. The "Course Outcome Assessment Tools Matrix" was produced by the members of the staff. This matrix illustrates the relative importance of every single tool with regard to the aforementioned CO evaluation. The tables that follow provide illustrations of the same concept.

#### 3.2.2 Indirect Assessment

A technique of CO evaluation that is deemed to be indirect is feedback received from students enrolled in the relevant course. It is necessary to use indirect methods of assessment for at least some of the course outcomes. A feedback has to be obtained in order to determine the degree to which the desired objective has been attained. At the conclusion of the course, a member of the teaching staff must collect comments from the students in order to complete the course outcome evaluation. It was requested that the members of the staff put together the course completion survey. It is necessary for the survey questions to be formulated in such a manner that they have a direct bearing on the Course outcomes that have been determined by the member of staff.

### 3.3 Attainment of Course Outcome

The student's performance may be evaluated using the attainment process, which records the student's growing body of knowledge as they make their way through the content of the course. Calculating CO attainment involves taking internal examinations, external examinations, or examinations at the end of the semester, in addition to completing assignments for both theoretical as well as laboratory classes, using both direct and indirect methods. The evaluation process employs both direct (through tests) and indirect (through surveys) means to better comprehend the various stakeholders' points of view.

In the past, a student's overall grade point average has been used to evaluate their performance. The greater it is, the more likely it is that all of the outcomes will be realised. OBE, on the other hand, emphasises the significance of GA through POs and COs and allows you to assess the extent to which each objective was met through a set of targeted inquiries. It is expected that all questions will be formulated at an appropriate level of knowledge, covering the entire range of course learning outcomes.

It would be the perfect accomplishment if all of the students received perfect scores. But in reality, doing both is very difficult, if not downright impossible. In light of this, a pragmatic perspective is adopted while acceptable thresholds are considered. If a specific number of students are able to meet or exceed a predetermined standard of performance, this is referred to as a threshold. If this threshold is met, it may be regularly reassessed in order to increase the level of accomplishment.

Since each question is associated with one or more COs, the degree to which a student has attained that CO depends heavily on how well they perform on the question they are attempting to answer. In Colorado, a student's attainment level is based on their test performance and the number of questions they attempted. To calculate the percentage of test-takers who attempted the question, divide the total number of test-takers by the total number of test-takers who attempted the question. If the proportion of students who attempted the task was lower than the threshold number, then their attainment was also considered to be zero. This is because a lower percentage of students attempting the task is an indicator that they do not have the required level of knowledge. The threshold for the attempt % may be determined by taking the average of the attempt percentage over the course of the previous three academic years. In the event that it is more than the threshold value, the CO attainment will be determined in accordance with the approach that is detailed below.

Sixty percent, which is equivalent to a first-class grade, is one possible cutoff point for the level of marks that are obtained. As a result, the percentage of students who achieved CO attainment is determined by the proportion of students who tried the question and achieved more over 60 percent of the possible points. The CO attainment percentage is calculated by dividing the total number of students who tried a question by the number of students who received a score equal to or higher than the minimum passing grade level. In light of this, the applicable score for the attainment value has been provided, with the threshold for the number of persons obtaining set at 60%. Therefore, the score is a three if the criteria is met by at least sixty percent of the students. If between 50 and 59% of students get the threshold marks, then the score is 2, if between 30 and 49% of students achieve the threshold marks, then the score is 1, and if fewer than 30% of students achieve the threshold marks, then the score is 0. For the sake of this illustration, the threshold for the minimum attempt percentage is set at 30%. It is a direct technique, but attainment is determined according to the weightage that is given to formative and summative examination grades [30].

When using the indirect method, CO attainment is calculated by tallying the number of students who gave the course objectives a score of 3 or higher on a scale from 1 to 5, with 5 being the highest possible score. Direct and indirect CO attainment weights may be combined in the following way to arrive at the combined final weighting.

$$\text{Final CO} = 90\% \text{TotalCO} + 10\% \text{CourseEndsurvey}$$

Throughout the course of the programme, academic and extracurricular activities may be included. POs 1 through 5 properly address knowledge and abilities, while POs 6 through 12 reflect the character, attitude, self vs others, self versus society, and other aspects of the individual. They are ingrained in students via extracurricular activities such as field trips to local businesses, lectures given by industry experts, seminars, projects, workshops, hackathons, and other events. All of them have a significant influence and bring about the necessary changes in students across a wide range of POs, including things like working together as a team, communicating ethically, managing money responsibly, and continuing to educate themselves throughout their lives. For each of the activities, the appropriate amount of weighting may be assigned correspondingly.

### 3.4 Correlation Between Programme Outcome and Course Outcome

It is possible to define each CO such that it addresses a different subset of programme outcomes. It is possible to establish a correlation between COs and POs by determining the degree of success of the mapping process with the assistance of correlation levels 1, 2, or 3.

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High). The evaluation methods that are used to measure the outcomes of courses and programmes are a significant factor in determining how successful mapping is. When determining the appropriate level for the aim, it is important to take into consideration the ideas made by the stakeholders. The relative power of certain POs may serve as the basis for the construction of a CO-PO matrix. In order to demonstrate mapping, we will use an example from the The Electronics Division's third-semester EIM (Electronics Instruments and Measurement) class, number ELX304. Understanding the connection between CO and PO is our end goal; we'll consider ourselves successful if we've achieved goal levels 1, 2, or 3[31]. The definitions of the Course Outcomes may be found in Table

TABLE III. CO STATEMENTS FOR ELX 304

Subject Code	Course Outcome Statements
ELX304.1	Students will be able to identify the main components of an instrumentation, as well as static and dynamic errors, as well as the dynamic and static features of an instrument, in the context of taking measurements.
ELX304.2	Students will analyse various test and measurement techniques, such as AC and DC bridges, to determine the unknown amount under estimation.
ELX304.3	Students will evaluate and contrast several types of oscilloscopes according to their respective functions and modes of operation.
ELX304.4	In this lesson, students will learn how to use a cathode ray oscilloscope (CRO) to measure current, voltage, frequency, and phase.
ELX304.5	Instruments like digital multimeters (DMMs), signal generators (SGs), and wave analyzers (WAs) would be covered so that students can gain an understanding of both analogue and digital measurement techniques.
ELX304.6	Students will be able to select a transducer for practical applications after learning its principle of operation, operating, construction, and characteristics.

Table IV details the CO target level established in relation to the PO for the relevant EIM outcomes. This benchmark was established using both direct and indirect methods of achievement.

TABLE IV. CO-PO MATRIX FOR ELX304

CO	PO <sub>1</sub>	PO <sub>2</sub>	PO <sub>3</sub>	PO <sub>4</sub>	PO <sub>5</sub>	PO <sub>8</sub>
ELX304.1	2	-	-	-	-	-
ELX304.2	-	2	-	-	-	-
ELX304.3	2	-	3	-	-	-
ELX304.4	-	-	-	-	2	-
ELX304.5	-	-	-	2	2	-
ELX304.6	-	-	-	-	2	2
ELX304(average)	2	2	2	2	2	2

## VI. CONCLUSION

In recent years, the vast majority of educational institutions that provide engineering degrees have been evaluating their degree programmes with the goal of enhancing the design of their curricula, as well as the teaching methods, assessment, and evaluation procedures. There is a set of precise rules that have been imposed by the government accrediting organisations for each school in order to define and evaluate the many different graduate Program Outcomes in conjunction with the traits of an NBA graduate. For the course Design and Analysis of Algorithms, offered by the Department of Computer Science as well as Engineering to undergraduates, the OBE implementation of CO as well as PO accomplishment has been studied. This article provides both a high-level overview of the OBE and a detailed analysis of its outcomes, including their associated accomplishments, assessments, and processes.

The application enables the teacher to discover the poorer course results and make the required modifications to enhance them. The programme may be used as an efficient tool for course self-evaluation.

Insights gained from analysing CO achievement data will help faculty members improve their methods of instruction. The primary purpose of OBE assessments is to aid students in developing transferable skills, and this will help them do just that. When determining the status of POs and PEOs, the completion of COs is

the most crucial metric to examine. Since this is the case, it can be argued that establishing, evaluating, and achieving CO is the seed for a successful accreditation, and also that genuine efforts in the classroom will lead to the realisation of PO, PEO, and the Mission and Vision of the Programme.

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