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Research Article

Direct and Indirect Evaluation Strategies for Course Outcome (CO)-Program Outcome (PO) Attainment of Engineering Physics Course

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Abstract
The constant pursuit of bettering goods, services, or procedures is known as continuous improvement. These initiatives may aim for "incremental" advancement over time or simultaneous "breakthrough" progress. This study examines the evaluation of course exit surveys used to rate first-year undergraduate engineering students at K J Somaiya College of Engineering, one of the higher educational institutions in Mumbai. Students' perceptions of teaching and learning, their knowledge and abilities linked to Program Outcomes (POs), their assessments of the contributions of their lecturers, their views on academic resources and overall academic performance were all covered in the course exit survey for the subject of Engineering Physics. Prospective institute graduates' questionnaires have been found to be one of the most useful tools for evaluating the program curriculum's strengths and weaknesses. The effectiveness of the engineering physics course on the students of the first year B. Tech is determined by student input on their performance and satisfaction. The study was conducted for academic year 2023-24 syllabus structure, for different branches of first year students. The course exit survey is floated among the students in every semester. Outcome-based education strategies have been validated when the entire curriculum aligns with the program outcomes. According to the survey, roughly 70% of participants concur that the curriculum for the Physics is appropriate and helps in enhancing their life-long learning. The objective is to evaluate the effectiveness of the course, identify areas for improvement, and understand students' perspectives on various aspects of the curriculum, teaching methods, and overall learning experience. The survey covers topics such as course content, teaching quality, assessment methods, and resources provided. The feedback collected is analyzed to provide actionable insights for enhancing the course structure and delivery.

Keywords: Blended Learning, Course Exit Survey, OBE, Online Grading, Pedagogy, Students Feedback

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1. INTRODUCTION

To make sure the graduates are adhering to the engineering standard, accreditation is crucial. Surveys are a useful tool for evaluating curricular programs, since they allow for the collection of data on student happiness and performance as well as program strengths and deficiencies. The Department of Science and Humanities at the Somaiya Vidyavihar University is constantly seeking feedback and opinions from its first year undergraduate learners regarding the curriculum, methods of instruction, and overall learning experience that students have during their first year engineering studies. The teaching and learning standards and quality can only be raised with the help of these feedbacks. Based on questionnaires provided to students at the conclusion of their final year semester, this study was conducted. Since 2014, this kind of questionnaire study has been carried out with the aim of evaluating the efficacy of the engineering physics curriculum for the first year undergraduate engineering students.

1.1. Literature Review

It would be acknowledged globally that the caliber of graduates generated is comparable to that of industrialized countries. The industry has more options in the present world, where the supply of graduates appears to be exceeding the demand. This is most likely one of the motivations behind the creation of the OBE. OBE is a style of curriculum design and instruction that centers on the real-world skills that students will be able to apply to their learning (Aina & Aina 2013). The fundamental idea behind OBE is the assumption that all students, despite of ability, gender, race, or socioeconomic situation, can learn. OBE also recommends that schools "design down" from the outcomes for all other areas of educational delivery, generating "exit outcomes" based on the opportunities and challenges that students will encounter after graduation (Amanah 2021, Adeyemo 2018, Bauk 2015). Transformation and the development of engineering programs have been addressed by numerous institutions as a major priority. Rapid technological advancements have also changed the demands and expectations of the industrial sectors for engineering university graduates (Béres 2012, Blurton 1999, Brekke 2010).

OBE is a method of instruction that concentrates on helping students acquire a certain goal or skill that they should all be able to perform at the conclusion of the course. Course Outcomes (CO), Program Outcomes (PO), and Program Educational Objectives (PEO) are typically included in the OBE evaluation. It implies that every student should be able to meet the specified CO, PO, and PEO or related skill level in OBE. Prior to anything else, the CO in OBE should be precisely defined in terms of the skills that students will learn in that specific course (Black 2009, Chit 2010, Dargham 2012). The lesson plan is then created in accordance with the outcomes. Curricula are designed and instructional methods are formalized with the goal of facilitating the intended CO in mind. Concerning OBE, another aspect would be the extent of the kids' knowledge. Consequently, the evaluation of CO is a crucial component in determining the extent of a student's information acquisition. It is challenging to determine whether or not the CO has been attained in the absence of valid and trustworthy assessment methods (Li 2019, Ramchandra 2014, Saxena 2015). A variety of assessment techniques have been used to evaluate OBE success in higher education institutions. Nonetheless, the most widely utilized methods of assessment are direct and indirect ones. These techniques result in the triangulation of data and improve assessment of the extent to which the course objectives are met. In a traditional assessment method, students self-report the scope of their learning process using a survey. However, since the results of this indirect evaluation approach simply represent the opinions of the students, it is unable to quantify student performance accurately (Ramchandra 2014, Saxena 2015).

There are several techniques that can be utilized for program assessments (Dudley 2015, Emery 2003, Li 2019, Blurton 1999, Brekke 2010). The following approaches can possibly be used in authentic assessment: verbal protocols, concept maps, physical and electronic portfolios, student surveys, focus groups, lab journals, and cognitive development. One crucial step in the continuous program improvement process is the evaluation of all the courses for the first year engineering program. Program outcomes are particular declarations of graduates' attitudes, abilities, and knowledge that support the accomplishment of program objectives. A vast and expanding corpus of research in higher education settings examines feedback and its importance and efficacy in student learning. In order to help students become autonomous learners who can track, assess, and manage their own learning, feedback is regarded as a critical strategy. It's possible that first-year engineering programs won't have much success recruiting fresh students. It is reasonable to assume that a student entering a four- or five-year engineering program will have questions regarding both what an engineer is expected to learn and what an engineer actually does after graduation.

Expert consensus on effective pedagogy has been achieved via decades of research on how engineering students learn. Effective pedagogy has entered the field even though this consensus offers engineering educators previously unheard-of opportunities to enhance student learning. The recent development of science education leads educators to explore new teaching and learning methodologies and reframe constructive classes and assignments to bring students' knowledge to the highest level of education by allowing learners to gain various skills that are reflected in their future. Feedback is information given to a student on how well they understood or used a skill after receiving training, usually in the form of a task or task completion (Emery 2003, Lock 2018, Marsh 1987). Feedback is meant to help pupils gain real comprehension in order to accomplish the task. Feedback is an intervention having a wide range of effects on achievement, even though it can spur tremendous growth. In response to these difficulties, Hattie & Timperley (2207) wrote "The Power of Feedback", which included a methodology to improve the impact of feedback on learning and influenced the way that modern educators see feedback practices in the classroom. The potential of feedback to improve learning has been further validated by more recent study on its effectiveness. Feedback needs to be addressed within a learning context in order to have a significant impact (Nasser 2002, Schmelkin 2002, Slimpson 1995).

Feedback from students includes their insightful comments, suggestions, and thoughts about their educational experiences, the general classroom environment and the teaching strategies dynamic. It provides educators with a special view on how well they are able to teach methods, enabling focused alterations, with upgrades that take into account the particular tastes and requirements of the student body. Accordingly, the incorporation of student input can promote a more student-centred and adaptable learning environment that fosters motivation, engagement, and enhanced results in the classroom (Skelton 2005, Tadjer 2018). Although the significance of student input is extensively acknowledged, its application and use poses a number of difficulties. In any case at all educational levels, receiving feedback is crucial for fostering confidence and competence in both educators and learners (Brinko 1993, Brookhart 2008). It helps with self-evaluation and defines good performance, growth, and offers educators and learners top-notch information to enhance instruction and learning. It is a means of exchanging written and verbal that promotes motivational beliefs between the teacher and the learner, as well as opportunities to close the distance between what is meant to be understood and acquired (Meyer 2003, Minero 2016, Mahadevan 2013).

By examining the advantages, difficulties, and recommended procedures related to student's feedback, the purpose of this study is to support the continuous discussion about improving educational encounters. In the end, one hopes that this research will enable teachers to produce settings for learning that put students first voices, resulting in better instructional strategies and better learning outcomes for all.

2. METHODS

The way that students view Physics subjects is closely linked to how they view the discipline. That is, it will be challenging for the student to transfer if their understanding of physics is restricted to understanding of quantum mechanics etc. Thus, the idea of applying Physics and science has less of an instrumental component. When it comes to engineering, it is ideal for pupils to approach physics and its learning with positivity so that their perspective of the significance of this particular subject enables them to recognize their application and applicability in various settings. Studies on attitudes or perceptions, however, tend to be somewhat general and infrequently highlight the significance of students' professional decisions. Certain scholars in the field possess substantial expertise in assessing attitudes regarding maths and physics, in addition to additional elements like education, scientific reasoning, dialogue, and engineering students' ability to work together. But we were unable to locate many studies committed to fostering an understanding of physics' applicability, especially with regard to technical subjects.

2.1. Research Type

In this study, we employed a descriptive survey research design. The primary objective was to gather detailed information about the current state of CO-PO alignment and the evaluation strategies used in engineering education. Through descriptive surveys, we were able to collect a broad range of data regarding participants' experiences, perceptions, and the implementation of evaluation strategies without manipulating variables. The study aimed to describe the existing practices and outcomes related to CO-PO alignment within the context of engineering education. We collected data through surveys designed to capture teachers' and students' perceptions of how well course outcomes (COs) align with program outcomes (POs), as well as their experiences with different evaluation strategies. The analytical approach comprised choosing the course at varying study levels. Three processes comprise the design and assessment of CO: planning, assessment, and analysis of the results. During the preparatory stage, the course syllabus on OBE using the taxonomy and defined cognitive domain level was created. The nature of each designed course outcome and there assessment in the teaching and learning process was organized appropriately. Considering the planning for instruction and learning, evaluation on the CO accomplishment was completed at the conclusion of the semester. Two categories of evaluations were taken into consideration: both direct and indirect. Three different forms of evaluation were employed for the direct method: Internal assessments in the form of Quizzes (online via LMS), in semester exams (tests), and end semester exams. Every course has a unique cognitive domain, CO, and assessment type. By the conclusion of the course, each student's individual marks were combined and examined to evaluate the CO accomplishment.

The various quantitative and qualitative evaluation techniques that can confirm students' abilities and knowledge at a given moment in time or over an extended period of time are together referred to as direct assessment. In general, this is seen as ongoing evaluation. The two categories used to calculate CO direct assessment are end-of-semester exams and continuous evaluation. This section provides an explanation of the techniques used in the direct assessment. Class tests are part of the theory courses' internal assessment process. The internal evaluation method and solution created by the relevant subject faculty are used to evaluate the performance of the students. Two online tests using the institute's personalized learning management system are part of the internal assessment process. Each semester, internal assessments consisting of multiple-choice questions were designed and administered for the theory courses. While CO1 and CO2 are covered for Internal Assessment 1 (IA1), second internal assessment (IA2) was carried out for the units that cover CO3, CO4, and CO5 (Figure 1). Additionally, oral and viva exams are used to evaluate students' abilities to exhibit their practical knowledge as well as their capacity for reasoning. This evaluation, which is done once a semester before to the final exams, covers every CO that has been defined. This aids students in getting ready for their final tests of the semester, which offer confidence and feedback on their efforts. Every semester, end-of-semester exams, or ESEs, are held in accordance with the examination controller's standards.

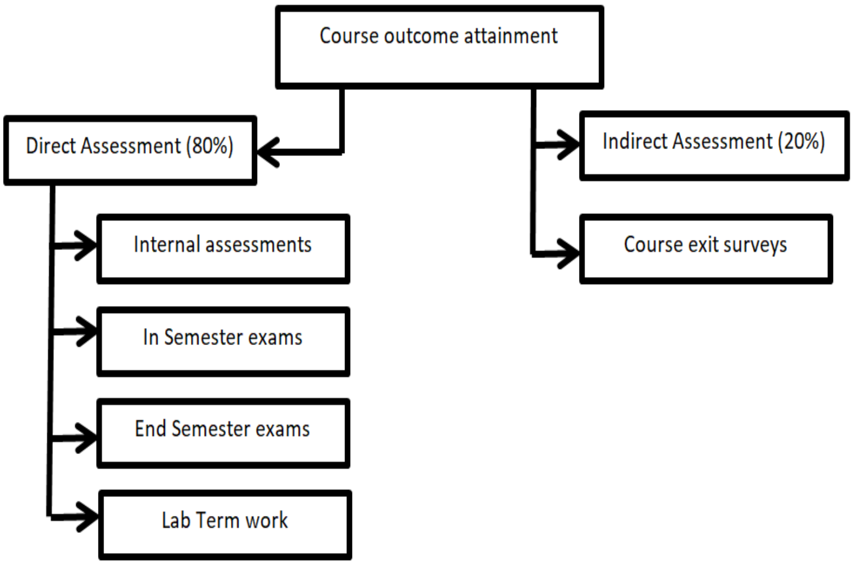

Figure 1. CO Attainment/Process Tools

Table 1. Course outcomes designed for the FY B Tech students for the subject of Engineering Physics

Course Module (SVU 2023)	Course Outcomes	Taxonomy Level
Photonics	CO1: Explain a variety of optical phenomena using concepts of wave optics and photonics	Understanding, Remembering,
Engineering Materials	CO2: Analyse basic physical properties of technologically important engineering materials	Remember, Understand, Analyze
Introductory Quantum Mechanics	CO3: Identify the scope of quantum mechanics in engineering and computing applications	Understand, Apply
Electromagnetism and Introduction to Plasma Physics	CO4: Solve engineering problems using mathematical foundations of plasma Physics and electromagnetism	Understand, Apply
Physics of Sensors for IoT Applications	CO5: Correlate physics of different types of sensors used in IoT applications	Understand, Analyze, create

The laboratory courses consist of term work grades, assignments, vivas, practicals, and multiple-choice question (MCQ) based lab quizzes. The end-of-semester exam was held for fifty marks in accordance with the instructions that were obtained from the exam cell. This descriptive assessment is done once a semester for each course and covers the whole syllabus that the institute has assigned (Table 1).

The metric for determining whether or not the CO is obtained is the combined results of the in-semester and end-semester exams for each semester. Exams are designed to help students achieve CO's by employing a descriptive approach. The total of ISE and ESE is used to calculate theory marks. Students receive their term work grades based on their assessments, which take into account their attendance, participation, and tutorial/lab results, among other things.

The course exit survey approach is used to determine the percentage of attainment in the indirect assessment of CO attainment. Eighty percent of the total achievement is attributed to direct evaluation, and the remaining twenty percent is attributed to indirect assessment. Students are asked to complete a course exit survey after roughly 95% of the material has been completed.

2.2. Participants

The study involved participants, consisting of around 700 students belonging to various branches of engineering. This sample size was chosen to ensure a comprehensive range of perspectives on the alignment of course outcomes (COs) and program outcomes (POs), as well as the effectiveness of evaluation strategies. Questionnaires regarding course satisfaction and outcomes are distributed to the students. Once a semester, the course coordinator/in-charge conducts this. The study was conducted among 350 students from different branches of the first year engineering programs (Mechanical Engineering, AIDS, RAI, CCE, EXTC, ETRX Engineering) in semester I and 350 students of Computers and IT branch in semester II at the higher educational institute (KJSCE). The survey's results, comments, and feedback are taken into account for the purpose of awarding COs and for the ongoing process of continuous development for the present and future academic sessions. To determine the attainment level and gaps, course exit survey data is reviewed. In accordance with the course requirements, necessary procedures and actions such as guest lectures, tutorials, mentoring, and review sessions are organized and carried out. The CO assessment also made use of the indirect method. At the end of the course, students are asked to rate the CO using a course exit survey questionnaire that was distributed to get their input. The poll on students' perceptions was created using the scale, where 3 is Strongly agree, 2 is agree, 1 is partially agree and 0 is disagree. Finally, results from several CO assessments methods were compared, averaged, and examined further.

2.3. Data Collection Method

The data for this study were collected using a method of survey collection i.e. online survey. Specifically, we administered a survey instrument type i.e. open-ended questionnaire to gather responses from the participants. The majority of the data were collected via an online survey platform i.e. Google Forms, which allowed for efficient distribution to participants and ensured anonymity. The online format was chosen to accommodate a wide range of participants and to facilitate easier data management. Invitations to participate in the survey were sent out through institutional email lists, with a follow-up reminder to increase response rates. In some cases, face-to-face distribution was employed, where surveys were distributed in-person during lectures or after classes to ensure comprehensive participation. The survey was open for two weeks, allowing enough time for participants to respond and for any clarifications or follow-up questions to be addressed.

2.4. Data Analysis Techniques

After collecting the survey responses, we employed various quantitative and qualitative data analysis techniques to analyse the data, depending on the nature of the questions asked. In this study, we utilized a combination of questionnaires to collect both quantitative and qualitative data. This instrument was selected to align with the research objectives of understanding Course Outcome (CO) and Program Outcome (PO) alignment and evaluating the effectiveness of various assessment strategies in engineering education. The primary data collection tool was a survey questionnaire that included both closed-ended and open-ended questions. The survey was designed to collect participants' perceptions of CO-PO alignment and their experiences with various evaluation strategies. The closed-ended questions primarily used Likert-scale items to measure participants' agreement with statements regarding CO-PO alignment and evaluation strategies. For example: "The learning outcomes of this course align well with the program's expected outcomes" (Likert scale: Strongly Disagree to Strongly Agree). "I believe the current evaluation methods used in this course adequately measure the intended learning outcomes" (Likert scale: Strongly Disagree to Strongly Agree). In addition to the Likert-scale questions, the questionnaire also included multiple-choice questions to capture specific details about evaluation methods used in the course, such as formative assessments, peer evaluations, and summative exams. To ensure that the instruments used in the study were valid for capturing the research objectives, we took several steps: The questionnaire and interview questions were developed based on a thorough review of relevant literature in the field of engineering education. Additionally, the instruments were reviewed by experts in engineering education and assessment to ensure that the questions addressed the key components of CO-PO alignment and evaluation strategies. The combination of quantitative and qualitative data collection instruments was highly appropriate for the research objectives. The questionnaire provided a broad overview of the perceptions of CO-PO alignment and evaluation strategies, which offered in-depth, contextual insights into the challenges and successes experienced by participants. The validity and reliability measures used ensure that the techniques used were robust and appropriate for addressing the research questions.

3. RESULTS

The teachers will enter information as stated below, including CO-PO mapping, target attainment, and direct and indirect assessment marks: (a) CO-PO mapping: Every question and CO analysis has the COs plotted against them, which is completed by teachers for every subject. The three CO assessments are low (1), moderate (2), and high (3) levels, in the direction of achieving PO. (b) Achieving the goal: the goal is established using the outcomes from the prior year. When the course is initially presented, the goal is established in accordance with the subject's degree of difficulty. (c) Assessment tools: The Direct and Indirect assessment tools are used in the attainment calculation. The Direct assessment consists of data such as Examination (In-semester exam, Internal assessments (minimum 2) and End semester examination), laboratory experiments (4). The indirect assessment generally includes components like a course exit survey which is taken at the end of the semester for the respective course. The feedback is evaluated and used in attainments of POs & COs. (d) Database: It is used to store CO-PO mapping, target attainment values, direct & indirect assessment data. It is also used to store the user credentials. It is accessed through the User interface.

Teaching-learning strategies that involve direct and indirect assessment can be used to compute course outcomes. Direct assessment includes term tests, assessments, and lab work, while a course exit survey is a google form with questionnaire based on each module (mapped to different CO) for the indirect assessment. The students are required to complete a feedback report regarding their course (11). After that, this input is assessed and utilized in the computation of program and course outcome achievement results. In Figure 3, the filled excel sheet is displayed. Calculations of accomplishment are made in accordance with the specified aim within the goal sheet. A course exit survey that is completed at the conclusion of the semester for the relevant course is often one of the components of the indirect assessment. The course-in charge gets ready with a survey form with inquiries pertaining to every course result. The survey could additionally ask topics about the way's lectures are delivered like PPT, chalkboard, debate in the group, lectures on video, etc. Then after that, analysis is completed by entering the information into excel sheet. Figure 5 displays an example of a course exit survey form (2). The aforementioned excel data has been entered into our system and course. After that, result attainment is computed. The system generates a summary sheet which displays CO attainment for individual CO's. The marks from each CO for every student are used to calculate the program outcome (7). The three levels of CO-PO mapping are high (3), moderate (2), and low (1). Additionally, systems produce observation sheets that indicate the success or failure of the planned PO accomplishment.

Direct and indirect assessment of student learning, motivation and course experience were completed for an engineering Physics graduate course. These direct measures were corroborated by indirect self-assessment by students of their ability to accomplish course learning objectives. Student motivation and interest in the course were found to begin and remain high throughout the course, portending good engagement with the material. Students reported they spent about 8-10 hours each week on tasks associated with the course. Special concern to the authors was students' feelings of connectedness considering the online course format; indeed, student estimations of their feelings of connectedness during the course were lower than desired. Students agreed that format, structure and organization were strengths of the online course. Table 2 here represents the CO's of Engineering Physics mapped with the suitable PO's.

Table 2. CO Mapping of Engineering Physics with the PO's

	Mapping of CO's to PO's and PSO's											
Course Outcomes	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**
EP_CO1	3			3			3					3
EP_CO2	3			3			3					3
EP_CO3	3			3			3					3
EP_CO4	2			2			2					2
EP_CO5	2			2			2					2
	2.60			2.60			2.60					2.60

As described in Table 3, a number of validated questionnaires were used for indirect assessments of student motivation. These results indicate that students were excited about the course and viewed it as personally meaningful while believing what they were learning was important. Students' course experiences were also probed using survey instruments. Based on the results of this study, the authors have identified a number of areas for improvement and future work. Since both direct and indirect assessments indicated that learning of Quantum Mechanics, Electrodynamics was weaker than for other content in the course. It was easy for students to navigate the course LMS site and to locate the course materials they wanted on the Moodle site; all respondents agreed, somewhat or strongly, that it was easy to navigate through the web pages covering each topic-based module.

4. DISCUSSION

Sixty-six percent of respondents agreed, somewhat or strongly, that the lessons' instructions and directions were written clearly. Open-ended answers to a variety of questions were gathered via the course exit survey and end-of-semester course assessments. Positive, reaffirming remarks about the caliber of texts and visual aids, as well as the instructor's communication were received. Some of the glimpses of the feedback given by the students are as follows: "The progression of the material was flawless, and the materials were well-organized. Details were carefully considered in the presentation of this course. Effective Communication: The instructors kept us informed of any updates and were always ready to answer queries. "I adore being able to see the in-class video lectures without physically attending classes. Being able to use the study material, PPT's and videos for the examinations was really beneficial to the students. Additionally, students offered helpful criticism and recommendations, primarily addressing unclear teaching and assessment materials.

Regarding the quizzes they gave the input about answering the unclear questions. Please make the questions simpler going forward and give multiple attempts. It is not possible to modify the course in response to student feedback. The helpful criticism points out several important areas that the writers should think about improving going forward: (i) In the future, please stick to the questions posted and if needed make changes weeks ahead of time (ii) I believe having more in-depth and rigorous example problems would benefit most students (iii) The videos for the example problems were very helpful (iv) Quizzes- The questions were ambiguous and only one attempt was given. In the future, please make the questions more straightforward and allow multiple attempts.

Table 3. Analysis on Data Collected Based on Proposed Course Exit Survey Questionnaire

	Course exit survey questionnaire to seek the feedback	3	2	1	0	Average (%)
S. No.	Feedback Questions					
1	The working principle of lasers and optical fibre along with their practical applications are well-covered through the course	100	51	4	0	87.3
2	The course sufficiently covered basic physics and applications of important engineering materials such as semiconductors, dielectrics and liquid crystals	83	66	6	0	83.2
3	Are the contents of the module on quantum mechanics sufficient to get an idea of basic concepts, mathematical formulations, some of its illustrative applications and the basics of Quantum computing?	65	69	18	3	75.5
4	Have you become acquisitive enough for the mathematical foundations and fundamental equations of electromagnetism after learning the module on electrodynamics?	64	70	18	3	75.27
5	Has the course helped you to correlate working of different types of sensors with the physics of materials and their application in various fields of science and technology?	65	74	15	1	76.99
6	Do you think IA in the form of MCQ Quiz proves to be a good assessment tool to grade the understanding of concepts/application of physics?	93	46	12	3	82.37
7	Do you think the laboratory experiments (hands-on + Virtual Labs) planned succeeded in increasing your understanding and ability to utilize classroom concepts?	86	52	14	3	80.86
8	How helpful were the supporting material like the shared Videos & PPT to provide enough information on the working of spectrometer, travelling microscope etc.?	88	57	9	1	83.23
9	Did the Lab Quiz helped to develop your interests/motivation towards learning /performing the experiments more sincerely?	74	59	12	10	75.70
10	Did the faculty use techniques, skill, and modern ICT tools necessary for teaching learning practices.	66	51	10	1	10

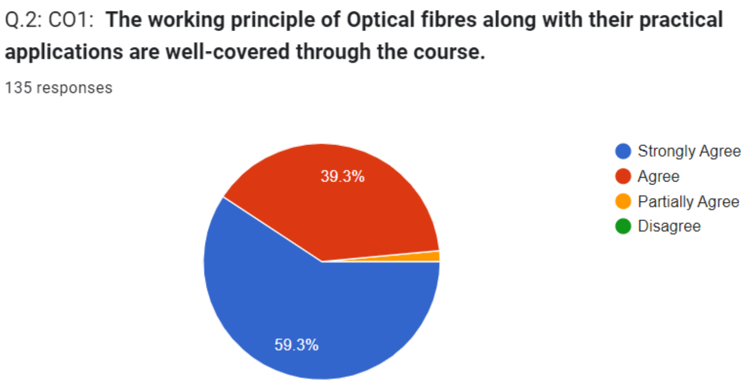

Figure 2. Students Response on the Topic of Optical Fibres

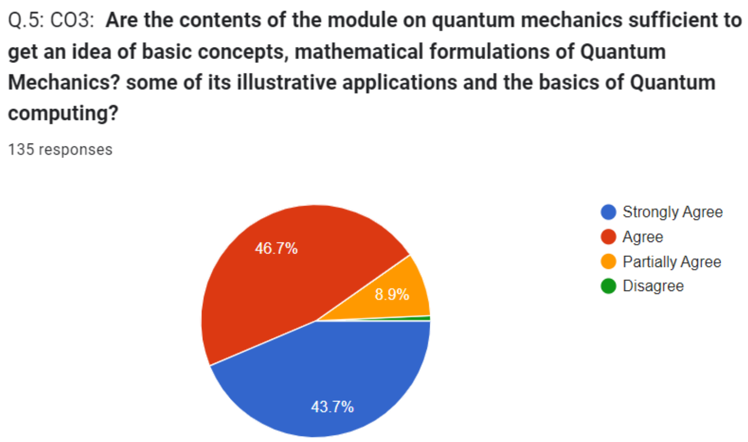

Figure 3. Students Response on the Understanding of the Concepts Related to Quantum Mechanics

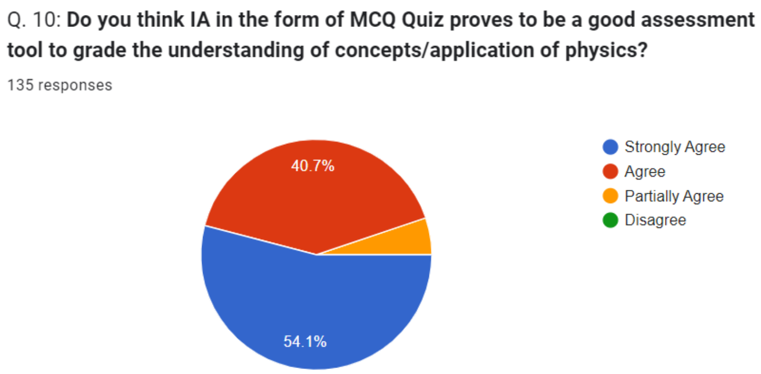

Figure 4. Students Response on the Assessment Techniques and the Grading System

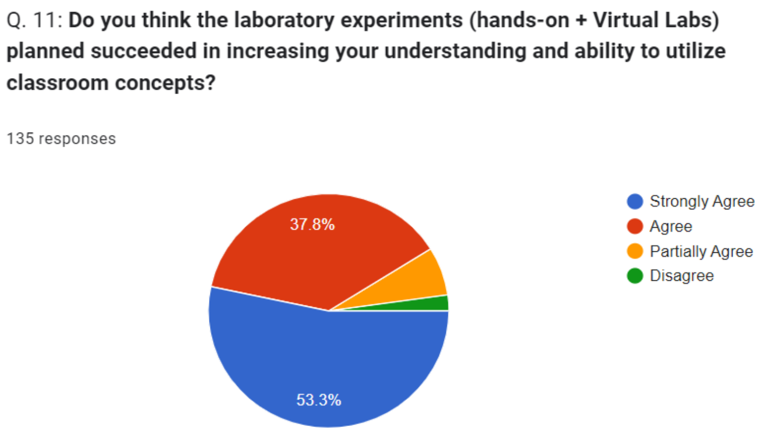

Figure 5. Students Response on the Lab Experiments Planned for the Current Semester

While changes should not necessarily be made to courses strictly based on student comments, being that this is the initial offering of the course, these comments would seem to be more likely to identify areas of instructor. The constructive critical comments identify a number of key areas for the authors to consider for improvement moving forward. Figure 2-6 represents the students response against the questionnaire shared with the students to get their feedback.

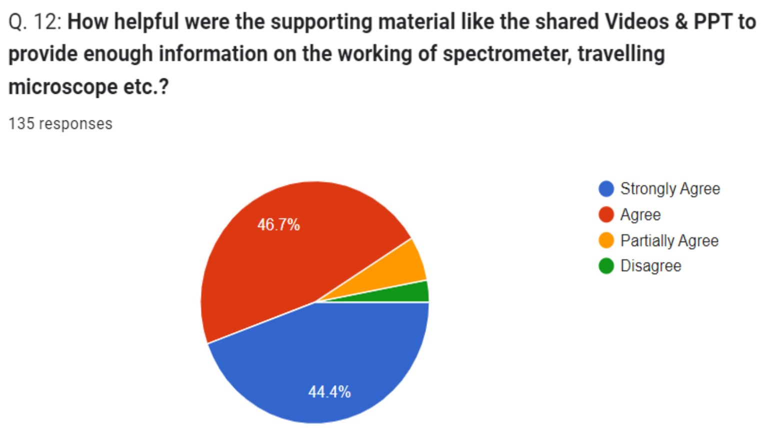

Figure 6. Students Response on the Supporting Material Provided for the Preparation of Lab Quiz, IA's and ESE

Figure 7 displays the system-generated observation sheet to show the CO mapping for the Physics course using the direct method of assessment tools like In-Semester exam, Internal assessments (Quizzes), End semester exams, Laboratory assessment like Lab Quizzes and experiments.

Assessment Tools for course outcomes: (Direct Method)								
Course Outcomes	Theory CA			Laboratory CA				Average Assessment
	ISE	IA-1	IA-2	Experiments	Quiz-I	Quiz-II	ESE	
EP_CO 1	39.71	40.99		86.50	82.97		60.95	62.23
EP_CO 2	36.19	40.99		85.70	82.97		34.56	56.09
EP_CO 3			40.70	50.21		62.95	25.96	44.95
EP_CO 4			40.70	31.48		62.95	22.02	39.28
EP_CO 5			40.70	31.48		62.95	5.79	35.23

Figure 7. Direct Assessment Tools Used for the CO Attainment

The CIS system generates the observation sheet, which shows whether the targeted PO attainment has been achieved or not. System generated observation sheet is shown in Figure 8 and 9. We say target is achieved if and only if the difference between the target set and attainment is less than or equal to 0.02, else target is not achieved.

Attainment of Course Outcomes					
Course Outcomes	Assessment in %		Average Assessment	Target Set	Attainment Level
	Direct (D)	Indirect (I)	(0.8*D+0.2*I)		
EP_CO 1	55.67	0.87	44.71	60	1
EP_CO 2	53.82	0.83	43.22	60	1
EP_CO 3	64.25	0.75	51.55	60	1
EP_CO 4	40.70	0.75	32.71	60	1
EP_CO 5	40.70	0.80	32.72	60	1

Target Set for CO 1			60	Levels
Below		10		0
Below	60	and Above	10	1
Between	60	to	70	2
Above			70	3

Target Set for CO 2			60	Levels
Below		10		0
Below	60	and Above	10	1
Between	60	to	70	2
Above			70	3

Target Set for CO 3			60	Levels
Below		10		0
Below	60	and Above	10	1
Between	60	to	70	2
Above			70	3

Target Set for CO 4			60	Levels
Below		10		0
Below	60	and Above	10	1
Between	60	to	70	2
Above			70	3

Target Set for CO 5			60	Levels
Below		10		0
Below	60	and Above	10	1
Between	60	to	70	2
Above			70	3

Target Set for CO 6				Levels
Below		10		0
Below		and Above	10	1
Between		to	10	2
Above			10	3

Figure 8. Attainment of the Course Outcomes Using Direct and Indirect Method of Assessments

In our case as is reflected from Figure 9, target level set for PO1, PO4, PO7 and PO12 is 3 and 2 respectively. But the attainment achieved is 1.40 for almost all the CO's which suggests that the PO is attained only upto the low level (1), hence we say target is not achieved. The possible reason for the gap in the target attainment could be identified as (i) If the course content is not fully aligned with PO expectations, there might be a mismatch between learning objectives and assessment techniques (ii) If the teaching methods are not engaging or interactive enough (e.g., too theoretical, not enough practical application), students might struggle to meet PO's (iii) If the assessments don't adequately reflect PO expectations (e.g., too focused on rote memorization, not enough on practical application or higher-order thinking) (iv) A lack of student engagement in activities like labs, discussions, and collaborative work could also contribute to a gap in PO attainment.

Contribution of Course Outcome in Program Outcome attainment														
Course Outcomes	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
EP_CO 1	2			2			2					2		
EP_CO 2	2			2			2					2		
EP_CO 3	1			1			1					1		
EP_CO 4	1			1			1					1		
EP_CO 5	1			1			1					1		
Engineering Physics	1.40			1.40			1.40					1.40		

Figure 9. PO Attainment for the Engineering Physics Course After the Course Completion

We can address the gaps by using the following possible methods: (i) update the course syllabus or modules to ensure better alignment with the PO's. Integrate more hands-on experiences, simulations, and real-world applications (ii) Incorporate methods like flipped classrooms, peer teaching, case studies, group projects, and experimental work to bridge the theoretical-practical gap (iii) Introduce more comprehensive assessments that evaluate students' application of physics concepts in real-world contexts (iv) professional development for instructors to better understand and implement active learning, feedback techniques, and interdisciplinary approaches (v) For students who are struggling, implement tutoring, peer support, or remedial classes focused on problem-solving skills and conceptual understanding.

We have elaborated on the key results of our study, focusing on the implications they hold for engineering education. The information of the direct and indirect assessment is compiled in the course information sheet so that it is easier to get an understanding about the CO attained in the specific course. We have explained how these outcomes contribute to a better understanding about the aspects of engineering education, e.g., student engagement, teaching methods, or learning outcomes.

In alignment with previous studies (Sani 2009, Obilar 2019, Chamberlain 2008), our results also highlights the effectiveness of the feedback for the students' development and change. It should come as no surprise that these students have arrived at college already familiar with the idea of identifying their interests and strengths, and fully understand the importance of these factors when choosing a course of study.

Raju 2018 explored strategies to improve engineering students' learning outcomes through a multidisciplinary approach, which can inform how courses like Engineering Physics contribute to broader program outcomes. Liew 2021 has demonstrated that the culminating assessment model effectively drives Continuous Quality Improvement (CQI) on engineering programmes with the educators' sustainable effort. An effective outcomes-assessment system should focus on selected courses or assessments that promote constructive alignment where educators are more readily to expand efforts on assessing and evaluating outcomes. Studies such as (Gastli 2009, Ahmed 2011, Kumar 2015) have explored Improved Course Assessment Measurement for Analyzing Learning, Enabling higher order thinking and technical communication, Innovative Program and Course Outcomes Assessment Tools, etc. providing contemporary perspectives on outcome based education. This literature reinforces our study's findings on CO-PO attainment for the subject of Engineering Physics, emphasizing the importance of various assessment techniques (formative, summative, indirect assessments on the curriculum design, student collaboration, or assessment practices.

The evaluation strategies used in our study provide educators with a structured and systematic way to assess whether the learning objectives are being met. By utilizing specific strategies, like formative assessments, peer evaluations, or rubrics, instructors can gather real-time feedback on student progress, enabling them to adjust teaching methods to address areas where students may be struggling. This feedback loop fosters a more responsive teaching approach and ensures that course content is delivered in alignment with the intended COs and POs. Additionally, by aligning evaluation strategies with both COs and POs, educators can enhance their teaching effectiveness by identifying which aspects of the curriculum require further emphasis or modification. At the institutional level, implementing these evaluation strategies can help ensure that the overall curriculum is effectively structured to achieve program-wide goals. By systematically evaluating CO-PO alignment, institutions can identify gaps in their curriculum, leading to improved coherence across courses and programs. This alignment helps institutions demonstrate the effectiveness of their educational offerings to accreditation bodies and stakeholders, thereby enhancing institutional reputation. Furthermore, these strategies support continuous improvement cycles, allowing institutions to refine their curriculum based on data-driven insights, ultimately improving educational quality and outcomes over time.

For students, the practical implication of using these evaluation strategies is an enhanced learning experience. By aligning evaluations with COs and POs, students gain a clearer understanding of how their learning connects to broader program goals. This clarity can increase motivation and engagement, as students see the relevance of their studies to their future careers. Moreover, the ongoing feedback provided through these evaluations helps students identify their strengths and weaknesses, enabling them to take proactive steps to improve their learning. As a result, students are better equipped to achieve mastery of course content and meet the expected program outcomes.

Overall, these evaluation strategies contribute to the continuous enhancement of the quality of education. They provide a clear, structured framework for ensuring that all components of the curriculum are effectively aligned with both immediate course objectives and long-term program outcomes. This approach promotes a more coherent and integrated educational experience, where teaching and assessment are aligned with the desired learning outcomes. By regularly assessing and refining CO-PO alignment, educational institutions can foster a culture of excellence, ensuring that students are well-prepared for the challenges of their professional careers and the demands of the engineering field.

5. CONCLUSION

A complex model where the giving and receiving of feedback has a significant impact on the learning process is shown by investigating the numerous types of feedback in the educational setting. Every kind of input, whether peer-based, online, oral, or written instruction is essential for promoting skill development and giving students the most individualized education possible. For both formative and summative purposes, written feedback is essential. Formative feedback helps students learn and develop, whereas summative feedback evaluates their final performance and reinforces what they have learned. The distinction between these responsibilities has evolved, acknowledging the value of providing ongoing feedback to improve the process of teaching and learning. Transparent communication, incentive, timeliness, and alignment with evaluation criteria are all necessary for effective online feedback. New technologies present contemporary chances to improve feedback. The authors' concerns about students feeling a lack of connectedness in the online course were verified, and measures aimed at improving this sense of connectedness and community will be investigated. Students felt that the recorded example problems needed additional depth in discussion and explanation as part of the solution, so new recordings will add to or replace existing example problems. Finally, students felt the conceptual quizzes taken from LMS were challenging enough such that multiple attempts should be offered. A quality OBE anticipates that every CO will be met. OBE anticipates an action plan for the continuous improvement process to do the same if any of the CO is not reached with the anticipated goal level. The goal of the OBE is to help students develop the information, abilities, and behaviours necessary to become globally competent experts. Students can also be evaluated using both quantitative and qualitative methods, and grades can be assigned. The authors review how student surveys serve as a tool for indirect assessment, with a focus on evaluating perceptions of teaching effectiveness, learning support, and course organization. The paper discusses how feedback is instrumental in identifying areas for improvement that may not be captured through direct assessments. All things considered, this paper highlights how effective feedback is for students' development and change. In order to use it effectively, educators must take a deliberate and focused approach that allows them to recognize students' needs and preferences. An outline of the function of feedback as a potent tool for students' development and transformation is also given in this article. Clarifying the feedback techniques can serve as a foundation for supporting each student's overall growth in a learning environment.

6. LIMITATIONS

The limited sample size may restrict the extent to which our findings can be generalized across diverse educational contexts, disciplines, or groups.

Another limitation is the scope of our study, which focused primarily on a single course, one institution, a particular student crowd or a specific set of outcomes. While this allowed for in-depth analysis, it may limit the broader applicability of the findings to other courses, disciplines, or educational settings.

The narrow scope of the study may restrict the ability to apply the findings to other educational contexts or to make general claims about engineering education in different settings or regions.

Future research could expand the scope by including additional courses, institutions, or subject areas. This would help to establish whether the observed trends hold true in other contexts and improve the external validity of the findings.

While the methodology used in this study like surveys, assessment-based evaluations etc., provided valuable insights, it also comes with certain limitations. For example, self-reported data from participants may be subject to biases. Additionally, the use of some specific tool or approach might limit the depth of the data collected in certain areas. These methodological constraints may influence the accuracy and depth of the data, leading to potential misinterpretations or oversimplifications of complex educational dynamics. In order to address this, future studies could employ mixed methods or triangulation techniques, incorporating both quantitative and qualitative data, to provide a more comprehensive and balanced view of the research question. Utilizing objective measures, such as performance metrics or standardized assessments, could also reduce bias and strengthen the findings. The timeframe of our study was limited, which may have influenced the extent to which we could track long-term outcomes or observe the effects of the evaluation strategies over time. A shorter timeframe may limit our ability to capture the lasting effects or to assess how the evaluation strategies influence student outcomes over time.

7. FUTURE RESEARCH SCOPE

Our study was conducted within a specific context, e.g. one institution, and particularly for the course of Physics, which may limit the generalizability of the findings. Comparative studies across multiple disciplines, institutions could provide a more comprehensive understanding of the factors that influence the success of evaluation strategies. For instance, examining how these strategies perform in interdisciplinary courses or in STEM education outside of engineering could yield valuable insights. Future research could explore alternative or complementary evaluation strategies such as digital assessments, competency-based evaluations, or machine learning algorithms to analyze student performance more effectively. Furthermore, exploring the integration of technology in assessment e.g., e-portfolios, AI-driven analytics could reveal new opportunities for improving CO-PO alignment. Research could also examine how CO-PO alignment influences students' problem-solving abilities, teamwork, and leadership in real-world settings. Future studies could also explore the impact of faculty professional development programs on the successful implementation of CO-PO alignment strategies. This could include examining how faculty training in assessment design, feedback techniques, and reflective teaching practices influences the overall effectiveness of evaluation strategies in achieving program goals. Exploring how students engage with formative and summative assessments and their feedback on evaluation methods may inform future improvements in curriculum design.

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