

Enhancing the Direct Assessment Method for ABET Accreditation: A Proposal for a Lightweight, Comprehensive, Precise, and Informative Approach

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Abstract

This study introduces a new method aimed at improving the direct assessment technique used for assessing students in the context of ABET accreditation. The traditional direct assessment method has long been utilized for ABET accreditation, involving steps such as goal identification, assessment planning, selection of assessment instruments, data collection and analysis, interpretation and evaluation, and feedback and improvement. While this approach has served as a valuable tool for evaluating student learning outcomes, it faces challenges related to complexity, resource-intensive requirements, and potential gaps in assessment coverage. Our proposed approach seeks to overcome the shortcomings of current assessment methods by proposing a streamlined, thorough, accurate, and insightful framework. By utilizing advancements in educational technology and teaching methods, this study seeks to enhance ABET accreditation procedures, promoting ongoing enhancements in engineering education.

Keywords: Student outcome assessment, ABET accreditation, assessment methodology, assessment metrics, continuous improvement, educational quality

INTRODUCTION

Engineering education has always been at the forefront of technological progress, producing skilled professionals who drive innovation and shape the world we live in. Ensuring the quality and effectiveness of engineering programs is paramount, and accreditation bodies like the Accreditation Board for Engineering and Technology (ABET) play a pivotal role in upholding these standards. ABET accreditation is a vital process that evaluates and assures the quality of engineering programs, instilling confidence in students, employers, and stakeholders alike [1, 2].

At the heart of ABET accreditation lies the assessment of student learning outcomes, a process that aims to measure the extent to which engineering students achieve the program's educational objectives. Direct assessment has been the traditional and widely utilized method for evaluating these outcomes.

The steps involved in the traditional direct assessment method are [3–5]:

Goal Identification

The first step in direct assessment is to define clear and measurable educational objectives and outcomes for the engineering program. These objectives typically align with ABET's general

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criteria and specific program criteria. Goals may encompass a wide range of skills and competencies, including technical knowledge, problem-solving abilities, communication skills, teamwork, and ethics.

Assessment Planning

Once the educational objectives are established, the assessment plan is devised to measure the extent to which students achieve these goals. The plan outlines the assessment instruments, data collection methods, assessment schedule, and responsible faculty or administrators.

Selection of Assessment Instruments

Assessment instruments are tools or methods used to gather evidence of student learning. These instruments can include examinations, quizzes, projects, presentations, lab reports, and capstone projects. Making the right instrument selection is essential to ensuring a thorough assessment of students' knowledge and abilities.

Data Collection and Analysis

During the academic term or program cycle, data is collected through the chosen assessment instruments. Faculty or evaluators review student work and performances and record the outcomes. The gathered data is subsequently examined to pinpoint patterns, strengths, and areas where student learning can be enhanced. Interpretation and assessment involve analysing the assessment data in comparison to the predetermined educational goals to determine the degree to which students have achieved the intended outcome. This stage enables educators and administrators to acquire insights into the efficacy of the curriculum and instructional approaches.

Feedback and Enhancement

Direct assessment offers valuable insights to faculty and program administrators for continuous improvement. This feedback is used to make informed decisions about curriculum enhancements, instructional strategies, and overall program improvements. By continually fine-tuning the educational process, institutions can strive for continuous improvement in engineering education.

Key features of traditional direct assessment methods are [6–8]:

1. *Structured Alignment*: The traditional direct assessment method is designed to ensure that the assessment instruments and data collection align closely with the educational objectives and outcomes of the engineering program.
2. *Periodic Assessment*: Assessment activities are conducted periodically throughout the academic year or program cycle, allowing for ongoing monitoring and improvement.
3. *Faculty Involvement*: Faculty members play a central role in the assessment process, as they develop assessment instruments, evaluate student work, and interpret the results.
4. Utilizing data collected from direct assessments offers evidence-based insights, facilitating decision-making based on data for curriculum improvement and program development. While the traditional direct assessment method has been instrumental in evaluating student learning outcomes, it is crucial to recognize its limitations, including resource intensity, administrative burden, and potential gaps in assessment coverage. Therefore, this study proposes a new approach that seeks to enhance the direct assessment method, making it more lightweight, comprehensive, precise, and informative. By embracing innovative strategies and leveraging technological advancements, this proposed framework aims to strengthen the assessment process, leading to continuous improvement in engineering education and ABET accreditation.

LITERATURE REVIEW

In the pursuit of enhancing academic accreditation, numerous research works have been conducted, addressing various aspects of the accreditation process. One of the primary goals of this research is to assist educational institutions in meeting accreditation criteria effectively. Scholars have documented their experiences with ABET certification, providing valuable insights into the accreditation process [1–4].

Among the essential duties in the accreditation process is program evaluation, which ensures that academic programs can consistently produce the desired student outcomes. Several studies have emphasized the significance of program evaluation in maintaining educational standards [5–9].

The landscape of accreditation efforts underwent a significant shift due to the COVID-19 pandemic, leading to the widespread adoption of remote tools and procedures for accrediting purposes. This recent impact has prompted researchers to explore the effectiveness and implications of remote accreditation methods across various sectors [10–14].

Furthermore, a wealth of literature focuses on education's continuous improvement procedures, as institutions strive to evolve and enhance their educational offerings continually. These studies highlight the importance of refining teaching practices, curriculum design, and learning environments to promote ongoing progress in academic programs [15–18].

Education that is outcome-based has also garnered attention in research literature. Emphasizing the significance of measurable learning outcomes, these studies advocate for aligning educational objectives with assessment strategies to ensure students' mastery of essential skills and competencies [19–22].

In contrast to previous studies that focused on general program evaluation and educational outcomes, our approach addresses the specific challenges faced by traditional direct assessment methods. By leveraging technology-driven assessment tools and adopting a multi-dimensional assessment model, we aim to streamline data collection, reduce administrative burden, and improve the accuracy of assessment outcomes. Furthermore, our framework emphasizes generating actionable feedback and insightful reports to foster continuous improvement in engineering education.

As the educational landscape continues to evolve, our efforts not only complement existing research but also provide a unique contribution by offering a practical and adaptable solution to the shortcomings of current direct assessment methods. Through the implementation of our proposed framework, engineering programs can achieve a more efficient and effective assessment process, leading to enhanced ABET accreditation outcomes and better-equipped graduates ready to tackle the challenges of the future.

TRADITIONAL DIRECT STUDENT ASSESSMENT METHOD

The conventional approach to direct student assessment involves a systematic method for evaluating and gauging student learning outcomes in engineering programs. The steps involved in this method are as follows [16–18]:

1. *Defining Program Syllabus:* The first step involves defining the overall syllabus and curriculum of the engineering program. This involves defining the content, goals, and educational outcomes that students are anticipated to accomplish during their academic progression.
2. *Defining Course Learning Outcomes (CLOs) of Each Module:* Each module or course within the program is broken down into specific learning outcomes. These CLOs delineate the quantifiable knowledge, abilities, and proficiencies students are anticipated to gain after finishing each module. Defining Performance Indicators (PIs) of each CLO: For each Course Learning Outcome, specific performance indicators are defined to assess and quantify the level of achievement. Performance indicators offer transparent benchmarks for assessing student performance concerning the intended outcomes.
3. *Aligning CLOs across various modules with Student Outcomes (SOs):* The Course Learning Outcomes are harmonized with the overarching Student Outcomes (SOs), reflecting the comprehensive educational aims of the engineering curriculum. This alignment ensures that the CLOs contribute to the attainment of the desired program-level outcomes.
4. *Determining the Attainment Level for the Selected Modules:* The attainment levels for each Course Learning Outcome in the selected modules are determined based on the performance of students. These Levels signify the extent to which students have attained the designated learning objectives.

5. *Performing Direct Assessment on Selected Modules:* Direct assessment involves the evaluation of student work and performances in the selected modules. Faculty or evaluators review assessments such as exams, quizzes, homework, projects, and other relevant activities to gauge student achievement.
6. Creating appropriate rubrics for the assessment process ensures uniformity and equity when evaluating student assignments. Rubrics provide clear and objective criteria for assessing the level of attainment of each Course Learning Outcome.
7. Utilizing the defined Performance Indicators for each Course Learning Outcome, we gauge the degree to which students have reached the designated objectives. These indicators provide quantitative data for assessment.

Determining the overall achievement of Student Outcomes involves aggregating the attainment levels of applicable Course Learning Outcomes across chosen modules and representing it as a percentage. This calculation offers a thorough assessment of students' collective progress in reaching the intended Student Outcomes (SOs) of the program. While the traditional direct student assessment approach has been widely used for evaluating student learning outcomes, it is not without its limitations and challenges. Some of the problems with this approach include [19, 20]:

1. *Resource Intensive:* The traditional direct assessment method can be resource-intensive, requiring significant time, effort, and personnel to implement effectively. Faculty members and administrators may find it burdensome to manage multiple assessment activities, especially in large academic programs.
2. *Limited Assessment Coverage:* Depending on the number of modules and courses within a program, it may not be feasible to assess every Course Learning Outcome (CLO) in all modules. As a result, certain learning outcomes might receive more emphasis, while others may be overlooked, leading to an incomplete picture of students' overall learning.
3. The overemphasis on exams and quizzes in traditional direct assessment methods may not comprehensively assess the diverse range of skills and competencies fostered throughout the learning journey, despite their value as evaluation tools.
4. *Subjectivity in Grading:* The assessment process involves human judgment and evaluation, which can introduce subjectivity and inconsistency in grading. Different faculty members may interpret rubrics differently, leading to variations in student assessments.
5. *Lack of Timely Feedback:* The traditional direct assessment method often involves time-consuming evaluation processes, leading to delayed feedback for students. This hinders their ability to identify areas for improvement promptly.
6. *Insufficient Integration of Technology:* While the proposed framework aims to leverage educational technology, the traditional direct assessment method may not fully embrace the potential of technological advancements to streamline data collection, analysis, and reporting.
7. *Cumbersome Data Management:* Handling and analysing the data generated through direct assessment can become cumbersome, especially in large engineering programs with numerous modules and students.
8. *Focus on Compliance rather than Improvement:* In some cases, the primary focus of direct assessment might be on satisfying accreditation requirements rather than utilizing the assessment data to drive meaningful improvements in the educational program.
9. *Limited Flexibility:* The traditional approach may lack the flexibility to adapt quickly to changes in curriculum, instructional methods, or emerging educational needs. This inflexibility may impede the integration of creative teaching and learning approaches. Despite these challenges, the traditional direct assessment method has provided valuable insights into student learning outcomes and program effectiveness. However, to address these problems and enhance the assessment process, it is crucial to explore innovative approaches that promote a more lightweight, comprehensive, precise, and informative assessment framework, aligning with the proposed goals of this study.

SUGGESTED DIRECT STUDENT ASSESSMENT METHOD

The improved assessment method expands upon the conventional direct assessment of students by overcoming its drawbacks and introducing innovative tactics for a more thorough and effective evaluation of student learning outcomes. The following stages delineate the crucial components of the enhanced assessment method:

1. **Program Syllabus Definition:** Analogous to the traditional method, the initial phase entails defining the program syllabus, delineating the content and breadth of the academic program.
2. **Classification and Weighting of Course Materials:** Course materials are categorized according to their significance and relevance in accomplishing Course Learning Outcomes (CLOs). A weight is given to each classed item based on how important it is in achieving the overall learning objectives.
3. **Defining Course Learning Outcomes (CLOs) for Each Module:** Following the conventional method, specific Course Learning Outcomes (CLOs) are established for each module, detailing the anticipated knowledge, skills, and competencies students should attain.
4. **Weight Assignment for Each CLO Across Modules:** In the enhanced method, each Course Learning Outcome (CLO) receives a weight to highlight its importance relative to other outcomes across modules, aiding in the overall assessment process.
5. **Connecting Different Module CLOs to Student Outcomes (SOs):** As with traditional methods, each Course Learning Outcome (CLO) contributes to the accomplishment of the intended student outcomes when it is aligned with the larger Student Outcomes (SOs) of the course program.
6. **Establishing Varied Attainment Levels for Different Modules:** The enhanced approach acknowledges the differing complexities and challenges of various modules by determining distinct attainment levels for each. A more comprehensive assessment of students' performance across a range of coursework is made possible by this customized assessment approach.
7. **Conducting Direct Assessment for ALL Modules:** In contrast to the conventional method, which may opt for selective module assessment, the enhanced approach mandates direct assessment for ALL modules. This comprehensive evaluation approach guarantees a thorough and encompassing assessment of student learning.
8. **Relying Solely on Final Exam for Direct Assessment:** To streamline assessment procedures, the enhanced method emphasizes direct assessment exclusively through the final exam, serving as a comprehensive and integrative measure of students' competencies and understanding.
9. **Utilizing Uniform Rubric for Final Exam:** To ensure fairness and consistency, the same grading rubric employed for the final exam is applied uniformly to assess student performance across all modules.
10. **Totalling the accomplishment levels of all Course Learning Outcomes (CLOs) across modules and taking into account the weights given to each CLO and module is how the Student Outcome accomplishment (SO%) is calculated.** This calculation provides a thorough assessment of the extent to which students have achieved the program's planned Student Outcomes (SOs).

The improved assessment approach aims to deliver a more streamlined, accurate, and thorough appraisal of student learning outcomes, addressing the drawbacks of the conventional method. By harnessing technology and optimizing assessment procedures, this approach intends to promote ongoing enhancements in engineering education and elevate accreditation endeavours.

Based on the steps outlined in the enhanced assessment method, we can identify the lightweight, comprehensive, precise, and informative features as follows:

1. **Lightweight:** Performing direct assessment based on the final exam only streamlines the assessment process, reducing administrative burden and saving valuable time and resources. Also, by focusing on the final exam as the primary assessment tool, the method avoids excessive assessment activities and data collection efforts, making it more efficient and user-friendly.
2. **Comprehensive:** The method ensures comprehensive coverage of student learning outcomes by performing direct assessment on ALL modules within the academic program. This method offers

a comprehensive perspective on students' performance throughout the curriculum. Aligning Course Learning Outcomes (CLOs) from various modules with Student Outcomes (SOs) guarantees that the evaluation corresponds with the program's overarching goals, encompassing all crucial skills and competencies. This synchronization guarantees that every Course Learning Outcome (CLO) plays a role in achieving the targeted student outcomes, promoting a thorough evaluation process.

3. *Precise*: By assigning specific weights to each module and Course Learning Outcome (CLO) based on its relative significance, the method ensures a precise evaluation of the importance of different learning objectives. This weightage reflects the relative emphasis placed on various CLOs in the assessment process.
4. *Informative*: The method provides actionable feedback for continuous improvement in engineering education. It extracts the attainment level of each Course Learning Outcome (CLO) from final exam grades, considering the assigned weights. This data-driven approach provides valuable information on students' achievement in meeting specific learning objectives, offering informative insights for improvement. Additionally, through the calculation of the Student Outcome Achievement (SO%) as the aggregate of weighted attainment levels, this approach offers a quantitative assessment of students' overall progress in achieving the designated Student Outcomes (SOs) of the program. This calculation offers informative data on the effectiveness of the academic program in achieving its educational objectives. Additionally, the use of a consistent rubric for the final exam facilitates clear and insightful evaluation of student work, enabling educators to identify strengths and areas for improvement effectively.

IMPLEMENTATION PLAN

In this part, we delineate the tangible actions necessary for enacting the suggested assessment methodology. We address the incorporation of technology, faculty training, and institutional backing to facilitate a smooth adoption of the innovative approach. We provide a case study that demonstrates the implementation of our recommended evaluation strategy in a computer engineering programme in order to demonstrate its effectiveness. We examine the results, difficulties faced, and overall effect on ABET accreditation.

Curriculum Preparation

Table 1 lists all of the courses, along with the specifics and weighting for each inside the improved assessment approach. The layout is structured according to academic level and semester, detailing each module's code, title, weekly workload (in hours), exam duration, credit hours, module type, and module weight. The credit hours allotted to each module signify its academic significance and form part of its weight within the program, encompassing theoretical, laboratory, and tutorial hours. Module type categorizes modules as Basic, while module classification as Basic, Core, or Supportive is determined by how well the module aligns with the educational objectives of the program. Module weight indicates the significance of each module, derived by multiplying its credit hours by the assigned weight corresponding to its module type. Courses such as "Computer Principles" (CE101) and "Mathematics 1" (CE103) at Level One, for example, are classified as Basic and have Module Weights of 10, indicating that they have a significant influence on meeting the course's learning objectives (CLOs) and student outcomes (SOs). On the other hand, classes like "English Language" (CE107), "Democracy" (CE109), and "Human Rights" (CE102) are categorised as Supportive and have lower Module Weights, indicating their supplemental position in the curriculum. Additionally, "Electrical Circuits Analysis 2" (CE111), "Programming using C++ Language" (CE108), and "Digital System Fundamentals" (CE112) are categorised as Core courses and have higher Module Weights (15, 21, and 18, respectively) because of their critical role in developing students' fundamental skills and accomplishing program-level goals. This Table 1 offers a succinct overview of program courses, their workload and credit distribution, and their respective contributions to assessment, forming a crucial basis for implementing the enhanced assessment method and ensuring a comprehensive evaluation of student learning outcomes throughout the program.

Table 1. Curriculum mapping.

Level	Semester	Module Code	Module Name	Student Work Load (h/w)			Exam Hours	Credit Hours	Module Type	Module Weight
				Theory (h/w)	Lab (h/w)	Tutorial (h/w)				
One	One	CE101	Computer Principles	2	3		3	5	Basic	10
		CE102	Human Rights	2	0		3	2	Supportive	2
		CE103	Mathematics 1	4	0	1	3	5	Basic	10
		CE104	Engineering Drawing by Computer	0	3		3	3	Basic	6
		CE105	Electrical Circuits Analysis I	3	3	1	3	7	Core	21
		CE106	Electronics Physics	3	0	1	3	4	Basic	8
	Two	CE107	English Language	2	0		3	2	Supportive	2
		CE108	Programming using C++ Language	2	3		3	5	Core	15
		CE109	Democracy	2	0		3	2	Supportive	2
		CE110	Mathematics 2	4	0	1	3	5	Basic	10
		CE111	Electrical Circuits Analysis 2	3	3	1	3	7	Core	21
		CE112	Digital System Fundamentals	2	3	1	3	6	Core	18
Two	Three	CE201	Engineering Mathematics 1	3	0	1	3	4	Basic	8
		CE202	Analog Electronics	3	3		3	6	Basic	12
		CE203	Microprocessors 1	2	3		3	5	Core	15
		CE204	English Language-Pte-intermediate	2	0		3	2	Supportive	2
		CE205	Object Oriented Programming	2	3		3	5	Core	15
		CE206	Programmable Logic Design using HDL	2	3		3	5	Core	15
	Four	CE207	Computational Methods for Data Analysis	2	0	1	3	3	Core	9
		CE208	Engineering Mathematics 2	3	0	1	3	4	Basic	8
		CE209	Engineering Management	2	0		3	2	Supportive	2
		CE210	Digital Electronics	2	3	1	3	6	Core	18
		CE211	Microprocessors 2	2	3		3	5	Core	15
		CE212	Data Structures	2	3	1	3	6	Core	18

Three	Five	CE301	Data Communications	2	3	1	3	6	Core	18
		CE302	Signals and Systems	3	0		3	3	Core	9
		CE303	Computer Architecture I	2	0	1	3	3	Core	9
		CE304	Computer Interface	2	3		3	5	Core	15
		CE305	Operating Systems I	2	3		3	5	Core	15
		CE306	Artificial Intelligence Principles	2	0		3	2	Core	6
	Six	CE307	Computer Networks	2	3	1	3	6	Core	18
		CE308	Digital Signal Processing	3	0		3	3	Core	9
		CE309	Computer Architecture 2	2	0	1	3	3	Core	9
		CE310	Embedded Systems	2	3		3	5	Core	15
		CE311	Operating Systems 2	2	3		3	5	Core	15
		CE312	English Language Intermediate	2	0		3	2	Supportive	2
Four	Seven	CE401	Professional Ethics	2			3	2	Supportive	2
		CE402	Fundamentals of Control Systems	3	3		3	6	Core	18
		CE403	Real Time Systems	2	3	1	3	6	Core	18
		CE404	Industrial Networks	2			3	2	Core	6
		CE405	Wireless Networks	2	3		3	5	Core	15
		CE406	Parallel Computer Architecture	2		1	3	3	Core	9
	Eight	CE407	Graduate Project	1	4		3	5	Core	15
		CE408	Computer Graphics	2			3	2	Core	6
		CE409	Cybersecurity	2			3	2	Core	6
		CE410	Mobile Systems Fundamentals	2	3		3	5	Core	15
		CE411	Image Processing and Applications	2		1	3	3	Core	9
		CE412	English language-Upper Intermediate	2			3	2	Supportive	2

Modules Types Weights: (Supportive: 1, Basic: 2, Core: 3).

CLO Weighting

An alternative weighting approach is required for this assessment method, known as CLO weighting. To illustrate this process, consider the following example: Table 2 provides a comprehensive overview of

a specific module, "Industrial Networks", including its Course Learning Outcomes (CLOs) and the methodology for assigning weights to these outcomes. This data is essential for comprehending the module's content and assessment structure. "Industrial Networks" is classified as a core course with a module weight of 6, highlighting its crucial contribution to fulfilling the program's educational goals. The module consists of multiple Course Learning Outcomes (CLOs), each indicating a particular skill or competency students should achieve. Table 2 includes the percentage contribution of each CLO in the syllabus (Number of Weeks/15), showing the portion of the module's duration allocated to teaching and evaluating each CLO. It reflects the weeks when the particular CLO is addressed in the syllabus. Furthermore, SO Linkage indicates whether the CLO is connected to Student Outcomes (SOs), illustrating the connection between specific CLOs and the more general program-level learning objectives.

CLO Weight (CLOW): The computed weight of every CLO is shown in this column. Multiplying the CLO% contribution by the SO linkage yields the weight. The final rating indicates how important each CLO is to achieving the overall goals of the programme.

Take into consideration the following instance as an example:

For CLO 3, "Analyse and identify communication methods", it is associated with SOs 2, 3, and 6. With a CLO Weight (CLOW) of 1.36, the CLO provides 34% of the curriculum time (weeks-5 through 9). Multiplying the SO linkage (3 linked SOs) by the CLO% contribution (34%/15 weeks) yields this number (1.36).

In a similar manner, the syllabus contribution and connection to the larger programme outcomes are used to evaluate and weight each CLO. These weights complement the overall assessment structure and shed light on the importance of each CLO in evaluating the module. The Table 2 concludes by succinctly summarising the assessment structure and content of the "Industrial Networks" module and illustrating how each course learning outcome is weighted in connection to the program's overall goals.

This clear and systematic approach aids in understanding the varying emphasis on different learning outcomes and offers direction for assessment within the module.

Table 2. Module description and CLO weighting.

Module Name: Industrial Networks Module Code: CE404 Credit Hours: 2 Module Type: Core Module Weight (MW): 6										
Course Learning Outcome (CLO)	Description	CLO% contribution in the syllabus (No. of Weeks/15)	SO linkage							CLO Weight (CLOW) (SO Linkage × CLO%)
			1	2	3	4	5	6	7	
1	Identify the need for network protocols during data exchange	13% (Week1, Week2)		×						0.13
2	Demonstrate the use of serial standards as required in an industrial plant environment.	13% (Week3, Week4)			×					0.13
3	Analyse and identify the methods of communications	34% (Week5-Week9)	×	×	×				×	1.36
4	Compare the different protocols used as industrial standards	27% (Week10-Week13)		×	×					0.54
5	Demonstrate a working programmable logic controller network in a simulated industrial automated application	13% (Week14, Week15)	×	×	×				×	0.52

Examination Strategy

The proposed examination strategy, aimed at effectively assessing Course Learning Outcomes (CLOs), offers several advantages by utilizing the final exam as a direct gauge of student knowledge. When students are prepared enough and exam logistics are handled well, this strategy works well. Here is a more thorough breakdown of this strategy:

1. *Direct Assessment of Student Understanding:* Students' comprehension, expertise, and understanding of the CLOs are directly assessed by means of the final test. It offers a quick evaluation of how effectively pupils have internalised and retained the material presented in the syllabus. Given that the exam is given at the conclusion of the course, it offers a thorough assessment of the students' comprehension of the material.
2. *Optimal Preparation and settings:* The tactic makes use of pupils who are well-prepared and meticulously set up exam settings. Students are anticipated to have deeply immersed themselves in the course material, enabling them to proficiently exhibit their comprehension. Furthermore, concentrated evaluation is supported by the exam setting, guaranteeing that students' performance accurately reflects their actual learning.
3. *Reduced Faculty Effort in Rubric Creation:* This method decreases the requirement for faculty members to develop a new rubric specifically for the exam. The exam can be taken using the same rubric that is used for continuous assessments. The assessment procedure is made simpler for teachers and students by this continuity. Both sides have a clear awareness of the evaluation criteria and expectations because they are both familiar with the current rubric.
4. The indicators of performance utilized to gauge students' achievement of CLOs are directly associated with their exam grades. The exam is a comprehensive assessment instrument that assesses students' knowledge and abilities concurrently in all CLOs. This alignment guarantees that the test accurately reflects the learning objectives and offers a solid foundation for gauging student performance.
5. By using the final exam as the main assessment method, the approach makes efficient use of faculty resources and time. It is not necessary for faculty members to create unique evaluations or rubrics, which simplifies their work. This method also removes the need for extra grading processes because the exam offers a comprehensive assessment already.
6. *Holistic Evaluation:* Because the exam is inclusive, students' performance is evaluated holistically across all CLOs. Exam questions reflect each of the CLOs, so it is possible to assess students' understanding of the full spectrum of learning objectives.
7. This method is especially useful for evaluating how various concepts are interconnected within the module.

Table 3 provides an organised method of setting up and getting ready for the final test for the "Industrial Networks" module, as an example. The process starts by establishing a predetermined number of questions for the exam (15), corresponding to the duration of the module's instruction, which spans 15 weeks. This methodical approach guarantees that the content of each week is given equal weightage in the evaluation. Following this structured and deliberate method ensures that the final exam serves as a thorough assessment tool, effectively evaluating all CLOs in accordance with their relevance to the syllabus. This method minimizes the requirement for an abundance of questions while guaranteeing that the assessment adequately reflects students' proficiency in the learning goals. It also helps teachers create exams that are fair, instructive, and represent the learning objectives of the course. The strategy ensures a detailed and thorough assessment of students' progress by correlating exam grades with the performance criteria linked to each CLO. Its efficiency in resource utilization and consistency with established rubrics facilitate a smooth and well-informed evaluation process, advantageous for both students and faculty.

Variable Attainment Levels

To enhance the sophistication of our assessment framework, we introduce variable attainment levels tailored to different module types in the curriculum. This novel approach adjusts attainment thresholds based on each module's significance, thereby refining the accuracy and applicability of our assessment methodology.

Table 3. Final exam sheet.

Examination Sheet (Example: Industrial Networks)	No. of Questions must be 15, same No. of Weeks	Structured, pre-arranged exam
All CLOs must be included and measured	No. of Questions to measures certain CLO is proportional to CLO contribution in the syllabus	CLOs contribution of questions grades
CLO1	2	13%
CLO2	2	13%
CLO3	5	34%
CLO4	4	27%
CLO5	2	13%

This approach is built upon acknowledging the various classifications of modules, which include CORE, BASE, and SUPPORTIVE categories. Every kind of module contributes to the overall learning outcomes of students and plays a unique role in determining their academic path. Therefore, we support a flexible strategy that recognises the many roles that different modules play in accomplishing programme goals.

For CORE modules, which are distinguished by their pivotal contribution to the program's fundamental competencies, the approach proposes a specific attainment threshold of 70%. This indicates that a significant majority of students, around 70%, should achieve 70% or more to demonstrate their mastery of these crucial concepts. This improved standard emphasises how important these modules are in forming students' knowledge.

In contrast, for BASE and SUPPORTIVE modules, which may emphasize foundational knowledge and supplementary skills, the approach suggests a more flexible attainment threshold of 60%. This adaptable criterion acknowledges the varying levels of emphasis these modules contribute to students' overall learning.

Furthermore, the method introduces the possibility of a more nuanced implementation, where specific CORE components could be assigned varied attainment thresholds based on the program's specialization. This high level of customisation closely corresponds to the unique needs of specialised programmes, guaranteeing that achievement levels correspond to the specific learning goals.

By integrating variable attainment levels associated with module types, our approach enables educators to tailor the assessment process to align with the program's overarching goals. Precision and equality are improved by this tailored method, which guarantees that evaluation standards correspond to the tasks of the modules. Furthermore, it acknowledges the students' varied educational experiences, which encourage enthusiasm and involvement in a variety of module kinds.

Student Outcome Calculation and Reporting

The core of the improved assessment technique centres on the meticulous calculation of Achieved Student Outcomes percentages (Achieved SO%), a procedure that vividly showcases the educational achievements of the program. This calculation captures the attainment of Course Learning Outcomes (CLOs) within a framework that acknowledges the varied achievements across different modules and their corresponding attainment levels. To kickstart this calculation, a meticulously crafted equation is utilized:

$$\text{Achieved SO\%} = S(\text{CLO1 and CLO3 of CE105} + \text{CLO2 of CE202} + \text{CLO4 of CE302}) \quad (1)$$

This equation serves as the foundation for evaluating student achievement across specific CLOs, covering a targeted range of learning objectives within the program.

The resulting Achieved SO% offers a holistic measure, indicating the extent to which students have absorbed and showcased the essential skills and competencies of the program.

An essential element of this computation is the adjustment of attainment levels to match the characteristics and objectives of each module. We support a flexible strategy that takes into account the variety of modules and their educational objectives. Therefore, our proposed approach establishes specific attainment levels customized for each module: for modules like CE105 and CE302 classified as "Core," a more rigorous criterion is defined, mandating that 70% of students exceed a 70% threshold to reach the attainment level. This higher standard is a reflection of how important "Core" modules are in developing core skills. In the case of module CE202, which is classified as "Supportive", the desired degree of attainment is set at 60%. This acknowledges the module's supportive nature, which enhances the program's main goals.

Each CLO's Attainment Level (Attainment Ratio (AR%)) is carefully assessed utilising the following fundamental ratio:

$$AR\% = \frac{\text{No.of students who pass the attainment level}}{\text{Total No.of students who attend the exam}} \tag{2}$$

This formula measures the proportion of students who meet the predetermined attainment level for a specific CLO compared to the total number of students taking the exam. Through the application of this calculation to each CLO mentioned in the equation, the Achieved SO% serves as a reliable indicator of students' overall achievement across the specified CLOs and their corresponding attainment levels. The final step in a carefully planned assessment process is the computation of the percentages for achieved student outcomes. By incorporating module-specific attainment levels and recognizing diverse standards of accomplishment, along with utilizing comprehensive ratios to assess students' proficiency in targeted learning outcomes, the resulting Achieved SO% provides a metric of educational effectiveness. This metric sheds light on the program's effectiveness in cultivating skilled engineers prepared to succeed in their respective fields.

Table 4 summarizes the outcome of the assessment procedure, providing a comprehensive overview of the final exam statistics and evaluation analysis. Every entry in the table makes a contribution to the thorough computation of the percentages representing achieved student outcomes (Achieved SO%). This Table 4 functions as a numerical portrayal of the assessment results for the modules CE105, CE202, and CE302 (as demonstrated in this instance).

Table 4. SO% Calculation and reporting.

Module	CLO#	Total No. of attended Students	No. of Students passed the attainment level	Attainment Ratio% (AR%)	Module Weight (MW)	CLO# Weight (CLOW)	CLO# Contribution (AR×MW×CLOW)
CE105	CLO1	40	22	55% (0.55)	21	0.13	1.5
	CLO3	44	25	57% (0.57)		1.36	16.27
CE202	CLO2	35	30	86% (0.86)	12	0.13	1.34
CE302	CLO4	40	30	75% (0.75)	9	0.54	3.64
Achieved SO% (SUM of CLO# Contributions)							22.75
Assessment Report of SO							
SO% Threshold (when AR% =60% or 70% for CLOs) = (1.9+20+1.1+3.4)=26.4							
SO% Attainment = Achieved SO%/SO% Threshold =22.75/26.4= 86%							
Achieved SO% is less than SO% threshold by 14%							
CLO1 is less than threshold (70%) by 15%							
CLO2 is higher than threshold (60%) by 26%							
CLO3 is less than threshold (70%) by 13%							
CLO4 is higher than threshold (70%) by 5%							

It showcases the evaluation outcomes for every Course Learning Outcome (CLO) across these modules, demonstrating both the accomplishment and impact of each CLO on the overall Achieved SO%. The contribution of a certain CLO to the final evaluation result is shown by the CLO# Contribution column. The Attainment Ratio (AR), Module Weight (MW), and Course Learning Outcome Weight (CLOW) are multiplied to determine it. One important metric that shows how well the programme has taught students the necessary information and abilities is the Achieved SO%. It is determined by adding up all of the pertinent CLOs' weighted contributions and comparing the result to the overall programme goals. This % is a useful measure of how well the programme works to get the intended results for the students. The computations detailed in this table are replicated for the remaining ABET SOs, offering a detailed insight into the assessment methodology, delineating the influence of student achievements on individual CLOs, module weights, and the program's overall attainment. The Achieved SOs% serve as the ultimate manifestation of the educational voyage, encapsulating the outcomes of concentrated learning and committed instructional endeavours.

The subsequent section of the table comprises the assessment report, providing an exhaustive examination of the Achieved Student Outcomes percentages (Achieved SO%) vis-à-vis the established thresholds for Student Outcomes (SO).

It offers a perceptive assessment of the program's instructional efficacy by contrasting the achieved results with the predetermined benchmarks. The report outlines each Course Learning Outcome's (CLO) performance, emphasising areas that align and those that require further effort. These observations act as a fundamental compass for specific educational improvements and adjustments, guaranteeing that student learning outcomes are maximally achieved. The complete assessment report is an essential resource for enhancing engineering education over time.

Analysing Required Resources

The final section of this study presents a thorough analysis of the resource requirements for both the traditional direct assessment methods and the proposed lightweight direct assessment method. The findings, outlined in the comparison Table 5, illuminate the substantial resource advantages offered by the innovative approach.

The traditional approach to direct assessment employs a comprehensive array of measured activities to evaluate student performance, encompassing quizzes, exams, tests, homework, assignments, final exam questions, projects, lab exercises, group work, mock consulting assignments, and final presentations.

Table 5. Required resources.

	Measured Activities/Module	Involved Parties (IP)	No. of Tasks (NT)/Module /Semester	Frequency of Tasks (TF)/Module/ Semester	Resources Indicator (RI)/Module =IP×NT×TF
Traditional Direct Assessment Methods	quizzes (Q), exams (E), tests (T), homework (H), assignments (A), final exam questions (F), projects (P), lab exercises (L), group work (GW), mock consulting assignment (MC), final presentations (FP)	Faculty Members, ABET Steering Committee, Examination Committee, Data Collection Committee, Data Analysing Committee	Maximum: 11 Average: 6	Minimum: 2	From 60 to 110
Lightweight Direct Assessment Method	Structured Final Exams (SF)	Examination Committee, Data Analysing Committee	1	2	6

The involved parties, including Faculty Members, the ABET Steering Committee, Examination Committee, Data Collection Committee, and Data Analysing Committee, collectively contribute their expertise to these activities. The number of tasks per module per semester can range from a minimum of 2 to an average of 6, with a maximum of 11 tasks. This diverse range of assessment activities demands significant attention and coordination. Consequently, the resource indicator per module (RI/Module) can vary widely, ranging from 60 to 110, underscoring the substantial resource investment required.

In stark contrast, the proposed lightweight direct assessment method streamlines the assessment process by primarily relying on Structured Final Exams (SF). This targeted approach involves a single task per module per semester and is managed by the Examination Committee and the Data Analysing Committee. This focused strategy emphasizes precision and resource efficiency. The resource indicator per module (RI/Module) for the lightweight method is consistently 6, indicating the notable reduction in resource demand.

The comparison table underscores a significant paradigm shift from resource-intensive traditional assessment methods to the resource-efficient lightweight approach. While the traditional method necessitates a diverse array of activities and substantial involvement from multiple parties, the lightweight method aligns with the guiding principle of simplicity and precision. By primarily relying on Structured Final Exams, the lightweight approach optimizes resource allocation, reduces administrative burdens, and streamlines the assessment process.

The efficient resource utilization of the lightweight method offers multifaceted benefits. It minimizes the involvement of multiple parties, streamlines assessment administration, reduces assessment-related coordination efforts, and optimizes resource allocation. This, in turn, liberates valuable time and expertise, which can be redirected towards refining teaching methodologies, strengthening curriculum design, and enhancing the overall educational experience.

Table 6. Benefits and concerns of suggested method.

Implications for ABET Accreditation	Benefits for Engineering Education	Concerns and Limitations
<ol style="list-style-type: none"> 1. Alignment with ABET Standards: The lightweight method enhances alignment with ABET's outcome-based assessment approach. It facilitates targeted evaluation of student learning outcomes, fostering a transparent link between educational objectives and assessment strategies. 2. Streamlined Data Collection: By minimizing assessment activities, the method simplifies data collection and analysis. This ensures that meaningful insights are gained from assessments and subsequently contribute to evidence-based decision-making during the accreditation process. 3. Enhanced Program Improvement: The precise assessment outcomes allow for focused program improvement efforts. Institutions can accurately identify areas for enhancement and allocate resources strategically to address specific learning gaps. 	<ol style="list-style-type: none"> 1. Focused Learning Objectives: The method's precision emphasizes targeted learning objectives. This helps students develop core competencies effectively and promotes a deeper understanding of key concepts. 2. Resource Efficiency: Institutions can allocate fewer resources to assessment administration, allowing educators to dedicate more time to instructional innovation and student engagement. 3. Curriculum Enhancement: Precise assessment data aids in refining curriculum design. By identifying strengths and weaknesses, educators can adapt teaching methodologies and content to enhance student learning experiences. 	<ol style="list-style-type: none"> 1. Narrow Focus: Critics might argue that a focus solely on final exams could overlook broader skills like critical thinking and communication. However, careful question design can address this concern. 2. Limited Diversification: Relying heavily on one assessment method might overlook the value of diverse assessment techniques that cater to varied learning styles. 3. Potential Resistance: Faculty accustomed to traditional methods may be resistant to change, necessitating comprehensive training and communication.

The adoption of a lightweight, comprehensive, precise, and informative assessment method carries significant implications for ABET accreditation, engineering education, and institutional efficiency. While it brings about significant benefits, it's crucial to recognize potential issues and constraints. Here, we discuss the multifaceted implications, address possible concerns, and emphasize the method's benefits as listed in Table 6.

CONCLUSION

In summation, the adoption of the lightweight, comprehensive, precise, and informative assessment method for ABET accreditation signifies a strategic approach that aligns with evolving educational needs. By embracing targeted assessment strategies, institutions can enhance learning outcomes, streamline resource allocation, and foster a culture of continuous improvement. While addressing potential concerns, the method's transformative benefits for engineering education and accreditation underscore its pivotal role in cultivating proficient engineers equipped for the challenges of the modern world.

REFERENCES

1. Anwar AA, Richards DJ. Comparison of EC and ABET accreditation criteria. *J Prof Issues Eng Educ Pract.* 2018;144(3):06018001. DOI: 10.1061/(ASCE)EI.1943-5541.0000364.
2. Bachnak R, Marikunte S, Shafaye A. Fundamentals of ABET accreditation with the newly approved changes. In *Proceedings of the ASEE Annual Conference and Exposition, Tampa, FL, USA.* 2019 Jun 18; 16–19.
3. Ali QI. An In-depth Comparative Study of Different ABET Accredited Computer Engineering Programs Using Self Assessment Reports. *Al-Rafidain Engineering Journal (AREJ).* 2023; 28(2): 226–236. doi: 10.33899/rengj.2023.137672.12244.
4. Ali QI. Surveying Different Student Outcome Assessment Methods for ABET Accredited Computer Engineering Programs. *Research Reports on Computer Science (RRCS).* 2023; 2(1): 56–76. <https://doi.org/10.37256/racs.2120232577>
5. Khan IH. A Unified Framework for Systematic Evaluation of ABET Student Outcomes and Program Educational Objectives. *Int J Mod Educ Comput Sci.* 2019 Nov 1; 11(11): 1–6.
6. Ahmad N, Qahmash A. Implementing Fuzzy AHP and FUCOM to evaluate critical success factors for sustained academic quality assurance and ABET accreditation. *PLoS One.* 2020; 15: e0239140.
7. Alhakami H, Al-Masabi B, Alsubait T. Data analytics of student learning outcomes using Abet course files. In *Proceedings of the Science and Information Conference, London, UK.* 2020 Jul 16–17. Cham, Germany: Springer; 2020; 309–325.
8. Dawood M-U-Z, Buragga KA, Khan AR, Zaman N. Rubric based assessment plan implementation for Computer Science program: A practical approach. In *Proc IEEE Int Conf Teach, Assessment Learn Eng (TALE).* 2013 Aug; 551–555.
9. Schoepp K, Danaher M, Kranov AA. The computing professional skills assessment: An innovative method for assessing ABET's student outcomes. In *Proc IEEE Global Eng Educ Conf (EDUCON).* 2016 Apr; 45–52.
10. Hussain W, Spady W, Naqash M, Khan S, Khawaja B, Conner L. ABET Accreditation During and After COVID19-Navigating the Digital Age. *IEEE Access.* 2020; 8: 218997–219046.
11. Karimi A, Manteufel R. Preparation of Documents for ABET Accreditation during the COVID-19 Pandemic. In *Proceedings of the ASEE 2021 Gulf-Southwest Annual Conference, Waco, TX, USA.* 2021 Mar 24–26.
12. Mohamed O, Bitar Z, Abu-Sultaneh A, Elhaija W. A simplified virtual power system lab for distance learning and ABET accredited education systems. *Int J Electr Eng Educ.* 2023; 60(4): 397–426.
13. Essa E, Dittrich A, Dascalu S, Harris Jr FC. ACAT: A web-based software tool to facilitate course assessment for ABET accreditation. In *Proc 7th Int Conf Inf Technol, New Gener.* 2010 Apr; 88–93.
14. Lam W, Xie H, Liu D, Yung K. Investigating Online Collaborative Learning on Students' Learning Outcomes in Higher Education. In *Proceedings of the 2019 3rd International Conference on Education and E-Learning (ICEEL 2019), Barcelona, Spain.* 2019 Nov 5–7; 13–19.

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15. Cabezas I. On combining gamification theory and ABET criteria for teaching and learning engineering. In Proc IEEE Frontiers Educ Conf (FIE). 2015 Oct; 1–9.
 16. McKenzie FD, Mielke RR, Leathrum JF. A successful EACABET accredited undergraduate program in modeling and simulation engineering (M&SE). In Proc Winter Simul Conf (WSC). 2015 Dec; 3538–3547.
 17. Peridier V. Faculty-directed continuous improvement regimen with intentional ABET/SO 1–7 Scaffolding. In Proceedings of the ASEE Virtual Annual Conference Experience, College Park, MD, USA. 2020 Jun 22–26.
 18. Zambrano C. Continuous improvement model to systematize curricular processes in the context of ABET accreditation. In Proceedings of the International Conference on Frontiers in Education: Computer Science and Computer Engineering (FECS), Las Vegas, NV, USA. 2019 Jul 29–Aug 1; 88–93.
 19. Rathy G, Sivasankar P, Gnanasambandhan T. Developing a knowledge structure using outcome based education in power electronics engineering. *Procedia Comput Sci.* 2020; 172: 1026–1032.
 20. Lavanya C, Murthy J, Kosaraju S. Assessment practices in outcome-based education: Evaluation drives education. In *Methodologies and Outcomes of Engineering and Technological Pedagogy*. Hershey, PA, USA: IGI Global; 2020; 50–61.
 21. Manzoor A, Aziz H, Jahanzaib M, Wasim A, Hussain S. Transformational model for engineering education from content-based to outcome-based education. *Int J Contin Eng Educ Life-Long Learn.* 2017; 27(4): 266–286.
 22. Xu Y, Liu P, Tang P. Exploration of outcome-based computational thinking education programs for teachers. In Proceedings of the 2nd International Conference on E-Society, E-Education and E-Technology (ICSET 2018), Taipei, Taiwan, 13–15 August 2018; Association for Computing Machinery: New York, NY, USA. 2018; 123–126.