

Enhancing Course Delivery through a Top-Down Approach to Course Assessment

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Abstract

One inherent challenge in the Outcome-Based Education (OBE) system is assessing the extent of achievement of Learning Outcomes due to the lack of a proper assessment model. The proposed assessment model employs a top-down approach, starting from Program Outcomes (PO) to Course Learning Outcomes (CLO), linked to Performance Indicators (PI). The OBE structure is hierarchical and nonlinear, allowing for feedback at any stage to the previous stage in the hierarchy. While assessment in the OBE setup is not inherently quantifiable, our model aims to provide a rough indication of performance. This proposed model is a closed-loop system where feedback in the form of measurable results is used to identify root causes and implement corrective measures in course delivery.

Keywords: Outcome based Education, Program Outcomes, Course Learning Outcomes

1. INTRODUCTION

Outcome Based Education (OBE) focuses on student learning outcomes rather than traditional approaches that prioritize teaching predefined content. A survey of literature (1) on Learning Outcomes (LO) reveals several similar definitions. These definitions emphasize that Learning Outcomes describe what learners are expected to achieve by the end of a course, rather than what the teacher plans to teach. OBE is designed around what is essential for students to accomplish after their learning experiences. This approach involves starting with a clear understanding of the desired student outcomes and then organizing the curriculum, instruction, and assessment to ensure these outcomes are achieved. It highlights the complexities of real-life situations and the significance of the professional roles students will encounter post-education. The philosophy of aligning education with the future needs of students and society is fundamental to establishing Educational Objectives of a Program. Under this philosophy, Spady (2) outlines four guiding principles of OBE that can be used to develop appropriate assessment techniques.

Principles of Outcome-Based Education (OBE)

1. **Clarity of Focus:** Teachers must clearly define what they want students to achieve by the end of their course. This principle ensures that assessments are aligned with predefined outcomes, making expectations transparent to learners and preventing surprises during evaluations.
2. **Designing Backwards:** This principle, closely related to the first, emphasizes starting curriculum design by defining learning outcomes. Instructional techniques are then developed by working backwards from these desired outcomes, followed by the creation of assessment rubrics to measure achievement.
3. **High Standards for All Students:** Teachers should set high standards for all students to help them reach their full potential. This principle encourages excellence and challenges students to perform their best.

4. **Providing Expanded Opportunities:** Every student should have the chance to meet high standards. Recognizing that students learn differently and at different paces, teachers must offer appropriate opportunities for each learner to succeed.

2. NONLINEAR HIERARCHICAL STRUCTURE OF OBE

The first two principles indicate that the structure of Outcome-Based Education (OBE) is hierarchical, as illustrated in Figure 1. At the top of this hierarchy are the learning outcomes of the specific program, referred to as Program Outcomes (PO). According to the Accreditation Board for Engineering and Technology (ABET) and the National Board of Accreditation (NBA), each program must establish broad educational objectives, known as Program Educational Objectives (PEOs), which should align with the mission statements of both the institute and the program itself. The program must then identify Program Outcomes, which encompass criteria 3a to 3k outlined by ABET/NBA (3,4). Following this, the next level involves defining Course Learning Objectives (CLOs) for individual courses, each of which relates to one or more POs. The degree to which each CLO aligns with the POs is determined based on individual judgment and is categorized as Low, Moderate, or High. This categorization helps teachers understand the assessment methods and the weightage to assign to various assessments.

Once the CLOs are identified, suitable instructional techniques are chosen to equip students with the necessary skills to achieve the desired outcomes. Finally, appropriate assessment methods are designed to evaluate student achievement of these outcomes. These methods may include tests, quizzes, seminars, course projects, lab assignments, and more.

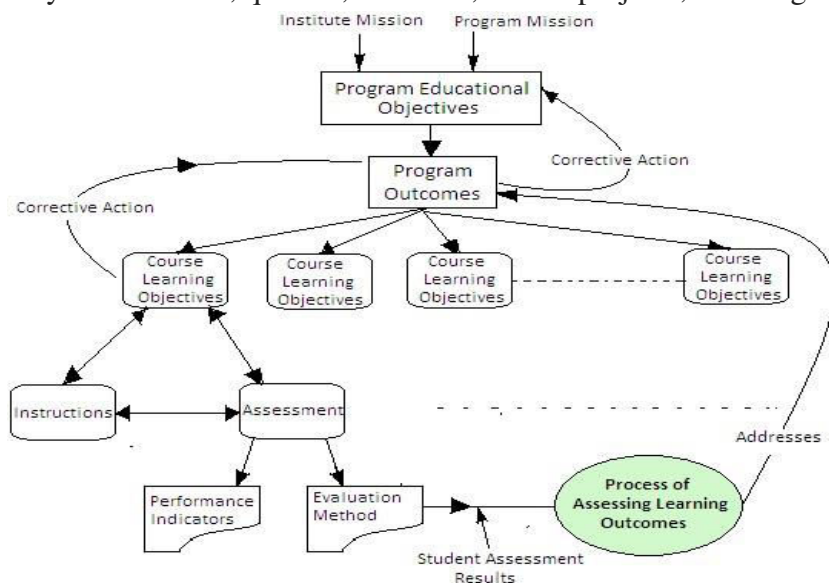


Figure1: Hierarchical and Nonlinear Structure of OBE

The course design method, which includes three key elements—framing Course Learning Outcomes (CLOs), designing instructional techniques, and identifying assessment methods—is not a linear process. Instead, it is iterative, allowing movement between these elements to implement corrective actions for improvement, as noted by Richard Felder. In this approach, assessment involves determining Performance Indicators (PIs) and selecting appropriate evaluation methods, which are discussed in detail in the following section.

3. ASSESSMENT

The four defining principles of Outcome-Based Education (OBE) significantly influence the assessment of student learning. The first two principles, clarity of focus and designing backward, require that teachers create a clear connection between all assessments and the Program Outcomes. This means that traditional subject-specific assessments are not enough for effective OBE. Instead, the methods of instruction, the delivery of knowledge, and the evaluation of achievements must all align and be transparent. Teachers need to establish specific assessment tasks and determine the extent to which students are expected to achieve each outcome, referred to as Performance Indicators (PIs), throughout the course. The principle of high expectations demands that assessment tasks be challenging rather than routine and traditional. Assessments should give students the chance to demonstrate a deeper understanding, allowing for a broad spectrum of performance levels to be identified. Lastly, the principle of expanded opportunity emphasizes a flexible approach to assessment. Students should be given multiple opportunities to achieve a high level of understanding, accommodating those who may not succeed on their first attempt.

Challenges: Creating effective assessment methods is a challenging endeavour because these methods need to adhere to several essential principles (5):

1. **Realism:** Assessment procedures should strike a balance, ensuring they are neither excessively demanding nor too easy. They must accurately evaluate the intended knowledge or skills.
2. **Reliability:** The methods should yield consistent and dependable results every time they are applied.
3. **Fairness:** Assessments must be impartial, not influenced by irrelevant factors such as the student's cultural or economic background.
4. **Relevance:** The assessments should align with the knowledge and skills that students are expected to acquire by the end of the course.
5. **Engagement:** They should stimulate curiosity and encourage deeper thinking in students.
6. **Clarity and Thoroughness:** Assessment tasks need to be clear and comprehensive, leaving no room for misunderstanding.
7. **Inclusiveness:** Given the diverse abilities of learners, assessments should offer various ways for students to demonstrate their understanding.
8. **Authenticity:** Tasks should provide genuine opportunities for students to showcase what they have learned, helping them recognize areas for further improvement.
9. **Educational Enhancement:** The primary goal of assessment should be to enhance learning, rather than merely assigning grades.
10. **Self-Assessment:** Prior to formal assessment, students should have the opportunity to evaluate themselves. This helps them understand the assessment criteria and encourages further learning.

Top Down Approach: The assessment process begins with the criteria outlined by ABET/NBA's Program Outcomes 3a to 3k. These outcomes are evaluated using both direct and indirect methods. Direct assessment methods involve examining students' knowledge or skills through tests or assignments that provide measurable performance indicators. Indirect methods, on the other hand, rely on surveys and self-reports to gauge student outcomes. A

performance indicator is a quantifiable measure used to determine how well a student has achieved a specific outcome. Given the complexity of assessment in Outcome-Based Education (OBE), each Program Outcome (PO) is broken down into simpler elements that reflect specific skills, knowledge, or abilities at the program level. Instructors then identify performance indicators at the course level for each element, which detail specific activities while maintaining a broad scope to assess the achievement of Course Learning Outcomes (CLOs) by students. This process also takes into account the assessment tools and instructional methods to ensure alignment with all stages of course design. An example of this top-down approach is illustrated in Figure 2.

PO a: An ability to apply basic knowledge in mathematics, science and engineering to solve basic problems of Instrumentation Engineering.		
PO a1 : Apply knowledge of mathematics	Courses	Method of evaluation
PI		
1. For a given mathematical expression provide an example of a suitable physical system	CS, S&S, DSP	Test and Exam
2. Formulate and solve mathematical models describing the behaviour and performance of physical systems.	CS, S&S, DSP	Test and Exam
3. Interpret basic signals using mathematical expression of basic signals. Represent filter using Block diagram.	DSP, S&S	Test and Exam, Activity (Physical model)
PO a2: Apply knowledge of science and engineering	Courses	Method of evaluation
PI		
1. Substitute given data in standard formula to obtain the required parameter, final expression /value.	PI, NA, SCC	Test and Exam, Activity (1. course project- SCC 2. Simulation-NA)
2. Determine static and dynamic characteristics for a given instrument/system.	EEM, VLSI	Test and Exam, Activity (practical assignment- EEM)
PO b: An ability to design, develop and implement experimental procedures for electronic, process control embedded systems and data acquisition systems as well as to analyze and interpret data		
PO b1 An ability to design experiments.	Courses	Method of evaluation
PI		

1. Identifies appropriate theory /concepts/ formula/ procedures for	AE-Lab.....,	Activity.....
::		
PO b2 An ability to conduct experiments.	Courses	Method of evaluation
PI		
1. Able to identify values/ ratings of a components, faulty components/IC's.	AE Lab, DE Lab, SCC Lab, TCS-Lab	Minor and SEE,
:		
PO b3 An ability to analyse the results.	Courses	Method of evaluation
PI		
:		
PO k: An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.		
PO k1 An ability to use the techniques necessary for engineering practice.	Courses	Method of evaluation
PI		
1. Interpret the graph obtained in terms of performance parameters such as linearity, sensitivity, bandwidth, gain, valve coefficient.	AE lab, SCC lab....	Open ended experiment

Figure 2: Sample Plan for Assessment (All the details are not shown in this sample)

The direct method of assessment encompasses examinations and various other activities designed to evaluate student performance. This method provides a structured approach to gauge the achievement of Program Outcomes (POs) through direct evaluation techniques. One way to assess learners using the direct method is through examinations. By analyzing the results from these assessments, educators can identify areas for improvement and take corrective actions to enhance curriculum delivery continuously. In this process, each examination question is linked to a specific Course Learning Outcome (CLO) and subsequently to the relevant PO criteria (a-k) using the course articulation matrix, as illustrated in Table 1. This mapping ensures that every question is aligned with the appropriate learning and program outcomes. After mapping, the performance on each question is evaluated based on the a-k criteria, as detailed in Table 2. To determine the average score for each question, the total marks obtained by all students who attempted the question are summed up and then divided by the number of students who attempted the question (n). The formula for calculating the average score is:

$$\text{Average Score} = \frac{\text{Total Marks}}{n}$$

This method allows for a detailed analysis of student performance and facilitates data-driven decisions to improve educational practices.

	Course: VLSI											
	Program Outcomes											
CLO	a	b	c		d	e	f	g	h	i	j	k
1	L					M						
2		M	M									
3	L	M	M			L						
4												M
5	L	M	M									

Table 1: Course Articulation Matrix

Q.No.	Max marks	Average Score	CLO	Criteria
Q1a	4	3.1	1	a, e
Q1b	6	4.8	3	a, b, c, e
Q1c	10	8.1	2	b, c
Q2a	08	5.7	3	a, b, c, e
Q2b	12	10.2	5	a, b, c
Q3a	05	4	2	b, c
Q3b	15	12.5	2	b, c
Q4a	5	3.6	3	a, b, c, e
Q4b	15	12.3	4	k
Q5a	4	3	3	a, b, c, e
Q5b	6	5	1	a, e
Q5c	10	7.8	1	a, e
Q6a	08	6.3	3	a, b, c, e
Q6b	12	10.1	1	a, e
Q7a	10	7.7	3	a, b, c, e
Q7b	5	4.2	5	a, b, c
Q7c	5	4.4	5	a, b, c
Q8a	15	11.4	4	k
Q8b	5	4.3	4	k

Table 2: Average score for each question

Criteria	% Attainment
a	79.5
b	79.6
c	79.6

d	--
e	70.5
f	--
g	--
h	--
i	--
j	--
k	81.3

Table 3: PO attainment for course on VLSI

To determine the percentage attainment of Program Outcomes (PO) 3a to 3k, refer to Table 2. The percentage attainment for each criterion (e.g., criterion 'a') is calculated by first finding the average score for every related question, then dividing this average score by the maximum possible marks for those questions. This process yields the percentage attainment for criterion 'a'. The same method is applied to all other criteria. To calculate the attainment of Course Learning Outcomes (CLO), you take the average of the attainment percentages of all related criteria. Additionally, direct and indirect assessment methods, such as exit surveys, alumni feedback, and employer feedback, are conducted using appropriate rubrics tailored to the specific activity or assignment. The PO attainment derived from these assessments is then averaged with the attainment obtained through the examination-based method described above.

4. FEEDBACK AND CORRECTIVE MEASURE

Based on the achievement of outcome criteria a-k displayed in Table 3, it is evident that the attainment of criterion 'e' is the lowest among all. If we assume that criterion 'e' also scored the least in other assessment methods (both Direct and Indirect), it becomes a point of concern. According to the course articulation matrix in Table 1, criterion 'e' is associated with Course Learning Outcomes (CLO) 1 and 3. To improve the results for criterion 'e', instructional techniques related to these objectives should be adjusted. If necessary, the Course Learning Objective (CLO) can be modified or a new CLO added to enhance the attainment of criterion 'e'. Given the iterative nature of the process, it is crucial to revisit and adjust the Program Outcomes and Educational Objectives accordingly.

5. CONCLUSION

Outcomes-based education (OBE) emphasizes the importance of student success, which can be achieved by employing authentic assessment techniques to evaluate student learning. Effective assessment methods should allow students to showcase their knowledge, skills, and abilities while also generating valuable data that helps identify and address any issues related to instructional methods or learning objectives, ultimately leading to improved learning outcomes. In our assessment model, we use a top-down approach to evaluate the attainment of Program Outcomes (POs) through examinations, which are considered direct methods of assessment. The results from this approach can be combined with other direct and indirect assessment methods to determine the final attainment of both POs and Course Learning Outcomes (CLOs). The assessment of learning outcomes occurs from the top of the hierarchy (PO) to the bottom (CLO), while corrective measures are implemented in the reverse

direction, from CLO to Program Educational Objectives (PEOs). This ensures that any necessary adjustments are made to enhance the overall educational experience and success of the students.

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