Outcome Based Education (OBE) in Engineering Colleges

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Abstract:

Today in most of the engineering colleges Outcome-based education (OBE) is a buzz word which every college wants to master in. OBE is an educational theory that bases each part of an educational system around goals (outcomes). By the end of the educational experience or course, each student should have achieved the goal. There is no single specified style of teaching or assessment in OBE; instead, classes, opportunities, and assessments should all help students achieve the specified outcomes. The role of the faculty adapts into instructor, trainer, facilitator, and/or mentor based on the outcomes targeted. Perhaps the majority of people do agree with the principles of OBE—or would if they understood them—but highly vocal critics have how raised enough questions about how OBE might work in practice to create doubts among informed members of the public about its desirability. OBE in Engineering Education system got popularity as National Board of Accreditation (NBA) made OBE as mandatory for giving the grades or making an Engineering College Accredited or not. OBE is not new, but yes, today it has given a new dimension in the way the different engineering colleges are functioning and it is helping the engineering academics to boost up. This paper primarily focuses on implementing OBE in the lime light of private engineering colleges in India which are not highly funded by government and basically self driven by dedicated private management to maintain quality engineering education in India.

Introduction

Should education be outcome-based? Some might argue that it already is, to some extent. Nearly all education institutions have goals that supposedly guide their work. When educators plan curriculums or teachers plan lessons for their classes, they usually start by clarifying the purposes. Still, advocates of OBE say that traditional colleges are really time-based. Teachers and principals may want students to learn something, but they typically allocate a certain amount of time to study of that topic and then move on, whether or not students have mastered it. For schools to be fully outcome-based, they must organize so that outcomes are fixed, and time and other resources needed to achieve the outcomes are variable.

OBE is more of a philosophy than a uniform set of practices. Many states and school systems have adopted the philosophy in part by emphasizing outcomes schools are expected to achieve, but few have changed all of their rules and regulations to be compatible with the notion that every aspect of schooling must be based on outcomes rather than on other considerations, such as length of the school year. Similarly, some programs that are consistent with the OBE philosophy do not use that terminology. Some have no special designation; some are called results-based or performance-based. The programs described below represent some of the varied approaches to OBE.

Outcome-based education (OBE) is an educational theory that bases each part of an educational system around goals (outcomes). By the end of the educational experience, each student should have achieved the goal. There is no single specified style of teaching or assessment in OBE; instead, classes, opportunities, and assessments should all help students achieve the specified outcomes. The role of the faculty adapts into instructor, trainer, facilitator, and/or mentor based on the outcomes targeted.

Outcome-based methods have been adopted in education systems around the world, at multiple levels. Australia and South Africa adopted OBE policies in the early 1990s but have since been phased out. The United States has had an OBE program in place since 1994 that has been adapted over the years. In 2005, Hong Kong adopted an outcome-based approach for its universities. Malaysia implemented OBE in all of their public schools systems in 2008. The European Union has proposed an education shift to focus on
outcomes, across the EU. In an international effort to accept OBE, The Washington Accord was created in 1989; it is an agreement to accept undergraduate engineering degrees that were obtained using OBE methods. As of 2014, the signatories are Australia, Canada, Taiwan, Hong Kong, India, Ireland, Japan, Korea, Malaysia, New Zealand, Russia, Singapore, South Africa, Sri Lanka, Turkey, the United Kingdom, and the United States.

Benefits of OBE

**Clarity**: The focus on outcomes creates a clear expectation of what needs to be accomplished by the end of the course. Students will understand what is expected of them and teachers will know what they need to teach during the course. Clarity is important over years of engineering education and when team teaching is involved. Each team member, or year in college, will have a clear understanding of what needs to be accomplished in each class, or at each level, allowing students to progress. Those designing and planning the curriculum are expected to work backwards once an outcome has been decided upon; they must determine what knowledge and skills will be required to reach the outcome.

**Flexibility**: With a clear sense of what needs to be accomplished, instructors will be able to structure their lessons around the student’s needs. OBE does not specify a specific method of instruction, leaving instructors free to teach their students using any method. Instructors will also be able to recognize diversity among students by using various teaching and assessment techniques during their class. OBE is meant to be a student-centered learning model. Teachers are meant to guide and help the students understand the material in any way necessary, study guides, and group work are some of the methods instructors can use to facilitate students learning.

**Comparison**: OBE provides an opportunity for comparison across institutions. On an individual level, institutions can look at what outcomes a student has achieved to decide what level the student would be at within a new institution. On an institutional level, institutions can compare themselves, by checking to see what outcomes they have in common, and find places where they may need improvement, based on the achievement of outcomes at other institutions. The ability to compare easily across institutions allows students to move between institutions with relative ease. The institutions can compare outcomes to determine what credits to award the student. The clearly articulated outcomes should allow institutions to assess the student’s achievements rapidly, leading to increased movement of students. These outcomes also work for school to work transitions. A potential employer can look at records of the potential employee to determine what outcomes they have achieved. They can then determine if the potential employee has the skills necessary for the job.

**Involvement**: Student involvement in the classroom is a key part of OBE. Students are expected to do their own learning, so that they gain a full understanding of the material. Increased student involvement allows students to feel responsible for their own learning, and they should learn more through this individual learning. Other aspects of involvement are parental and community, through developing curriculum, or making changes to it. OBE outcomes are meant to be decided upon within a school system, or at a local level. Parents and community members are asked to give input in order to uphold the standards of education within a community and to ensure that students will be prepared for life after school.

Drawbacks of OBE

**Definition**: The definitions of the outcomes decided upon are subject to interpretation by those implementing them. Across different programs or even different instructors outcomes could be interpreted differently, leading to a difference in education, even though the same outcomes were said to be achieved. By outlining specific outcomes, a holistic approach to learning is lost. Learning can find itself reduced to something that is specific, measurable, and observable. As a result, outcomes are not yet widely recognized as a valid way of conceptualizing what learning is about.

**Assessment problems**: When determining if an outcome has been achieved, assessments may become too mechanical, looking only to see if the student has acquired the knowledge. The ability to use and apply the
knowledge in different ways may not be the focus of the assessment. The focus on determining if the outcome has been achieved leads to a loss of understanding and learning for students, who may never be shown how to use the knowledge they have gained. Instructors are faced with a challenge: they must learn to manage an environment that can become fundamentally different from what they are accustomed to. In regards to giving assessments, they must be willing to put in the time required to create a valid, reliable assessment that ideally would allow students to demonstrate their understanding of the information, while remaining objective.

Generality: Education outcomes can lead to a constrained nature of teaching and assessment. Assessing liberal outcomes such as creativity, respect for self and others, responsibility, and self-sufficiency, can become problematic. There is not a measurable, observable, or specific way to determine if a student has achieved these outcomes. Due to the nature of specific outcomes, OBE may actually work against its ideals of serving and creating individuals that have achieved many outcomes.

Involvement: Parental involvement, as discussed in the benefits section can also be a drawback, if parents and community members are not willing to express their opinions on the quality of the education system, the system may not see a need for improvement, and not change to meet student’s needs. Parents may also become too involved, requesting too many changes, so that important improvements get lost with other changes that are being suggested. Instructors will also find that their work is increased; they must work to first understand the outcome, then build a curriculum around each outcome they are required to meet. Instructors have found that implementing multiple outcomes is difficult to do equally, especially in primary school. Instructors will also find their work load increased if they chose to use an assessment method that evaluates students holistically.

Few world famous models of OBE –

The Johnson City Model
A well-established example of OBE in actual use is the Johnson City, New York, schools (Vickery 1990). The Johnson City program, called by its developers the Outcomes-Driven Developmental Model or ODDM, was launched by John Champlain in the early 1970s. The program was originally described as a mastery learning program (the term outcome-based was not in use at that time). Al Mamary, former superintendent, says the major difference between mastery learning and ODDM is that ODDM puts increased emphasis on the student’s role. In a mastery learning program, teachers take responsibility for making sure that most students learn. Under ODDM, students are informed of the outcomes and expected to assume responsibility for achieving them (Brandt 1994). ODDM is described as having a strong philosophical and psychological base as well as a technical one.

The High Success Network
Perhaps the best-known model of OBE was developed by Bill Spady and his associates at the High Success Network. Spady lists four principles that he believes should characterize OBE:

Clarity of focus (having specific outcomes gives a strong sense of purpose to everything teachers and students do).

Design down, deliver up (when planning curriculum, educators start with the outcomes and work backwards; when planning instruction, teachers teach what students need to learn to demonstrate the outcomes).

High expectations (OBE departs from traditional education in its assumption that all students can learn well—although not in the same way and not necessarily on the same day), an.

Expanded opportunities (students must be permitted to demonstrate their learning in different ways, and they must have numerous opportunities to demonstrate the outcomes, not just one. Spady calls this “grading in pencil”).

Concerned that some people equate outcome-based education with mastery learning, Spady and his colleague Kit Marshall have developed a way of categorizing OBE programs. Mastery learning, they explain, is a technique for insuring that more students learn well, but it applies to any content. Outcome-based education
incorporates the principles of mastery learning but goes beyond them to be concerned with what students are to learn and why.

Spady and Marshall use the term traditional OBE for OBE programs in which the outcomes are defined as mastery of traditional subject matter: English, mathematics, science, and so on (Spady and Marshall 1991). Programs with content outcomes but also higher order outcomes such as being able to work with others are transitional. Spady and Marshall advocate transformational OBE, in which outcomes are derived from careful analysis of what students must be able to do to succeed in the future. These transformational outcomes are demonstrations of life “performance roles” such as problem solver and teacher (Spady 1994). The action planning workbook by Charles Schwahn that follows in this chapter of the ASCD Curriculum Handbook stems from this TOBE approach.

The McREL Model
An approach complementary to OBE that many educators have found to be helpful is the performance assessment system developed by Bob Marzano and associates at the Midcontinent Regional Educational Laboratory (McREL). Responding to educators whose school systems have adopted transitional outcomes and who need a valid way to assess them, the model involves writing performance tasks that specifically include elements of several different outcomes in one challenging task (Marzano, Pickering, and McTighe 1993). Because assessment of student performance is an essential part of OBE, the Marzano model is a useful supplement to transitional OBE programs.

Educators who accept the OBE philosophy begin by involving teachers, parents, citizens, and students in establishing the outcomes students are to demonstrate. These outcomes may be traditional—in terms of subject matter—or may include other outcomes, such as ability to communicate in a variety of forms, or the ability to perform life roles, such as “creators and producers.”

When outcomes have been established, educators should design curriculum to give students the knowledge and skills they need to demonstrate the outcomes. In many cases the outcomes will be such that they can be assessed only with performance assessment, not conventional tests, so the school’s assessment processes will need to be different. Finally, educators need to examine every other aspect of the school’s operation to determine what changes are needed—in grading policies, for example—to insure that larger numbers of students will in fact be prepared to demonstrate the outcomes.

OBE Principles and Process

OBE Principles
There are different definitions for outcome-based education. The most widely used one is the four principles suggested by Spady (1994):

Clarity of focus: This means that everything teachers do must be clearly focused on what they want students to know, understand and be able to do. In other words, teachers should focus on helping students to develop the knowledge, skills and personalities that will enable them to achieve the intended outcomes that have been clearly articulated.

Designing down: It means that the curriculum design must start with a clear definition of the intended outcomes that students are to achieve by the end of the program. Once this has been done, all instructional decisions are then made to ensure achieve this desired end result.

High expectations: It means that teachers should establish high, challenging standards of performance in order to encourage students to engage deeply in what they are learning. Helping students to achieve high standards is linked very closely with the idea that successful learning promotes more successful learning.
Expanded opportunities: Teachers must strive to provide expanded opportunities for all students. This principle is based on the idea that not all learners can learn the same thing in the same way and in the same time. However, most students can achieve high standards if they are given appropriate opportunities.

OBE Process

'Constructive alignment' is the process that we usually follow when we build up an OBE syllabus. It is a term coined by Professor John Biggs in 1999, which refers to the process to create a learning environment that supports the learning activities appropriate to achieving the desired learning outcomes. The word 'constructive' refers to what the learner does to construct meaning through relevant learning activities. The 'alignment' aspect refers to what the teacher does. The key to the alignment is that the components in the teaching system, especially the teaching methods used and the assessment tasks are aligned to the learning activities assumed in the intended outcomes.

Defining Curriculum Objectives and Intended Learning Outcomes

- Designing Assessment Tasks
- Selecting Teaching and Learning Activities
- Tips: Reviewing your Program-level Outcomes
- Tips: Writing Intended Learning Outcomes
- Tips: Choosing an Appropriate Outcome-based Assessment Tool and Method
- Example: An Outcome-based Assessment Marking Scheme

Defining Curriculum Objective and Intended Learning Outcomes (ILO)

A learning outcome is what a student CAN DO as a result of a learning experience. It describes a specific task that he/she is able to perform at a given level of competence under a certain situation. The three broad types of learning outcomes are:

- Disciplinary knowledge and skills
- Generic skills
- Attitudes and values

Guidelines for Producing Effective ILO Statements

Outcomes are about performance, and this implies:

- There must be a performer – the student, not the teacher
- There must be something performable (thus demonstrable or assessable) to perform
- The focus is on the performance, not the activity or task to be performed

One could start with this stem:

On successful completion of the programme, a (name of program) graduate will be able to [action verb] + [activity].

- Example 1: A graduate of this program will be able to effectively evaluate research designs, methods, and conclusions.
- Example 2: Graduates of this program will be able to assess their own strengths, weaknesses, and omissions and be able to adjust future performance in light of their self-assessments.
- Example 3: Graduates of this program will be able to effectively communicate both formally and informally through speaking, writing, and listening.

Designing Assessment Tasks

Outcome-based assessment (OBA) asks us to first identify what it is we expect students to be able to do once they have completed a course or program. It then asks us to provide evidence that they are able to do so. In other words, how will each learning outcome be assessed? What evidence of student learning is most relevant for each learning outcome and what standard or criteria will be used to evaluate that evidence? Assessment is therefore a key part of outcome-based education and used to determine whether or not a qualification has been achieved.
Types of Assessment Tools and Methods

**Formative assessment** : The collection of information about student learning during the progression of a course or program in order to improve students learning. Example: reading the first lab reports of a class to assess whether some or all students in the group need a lesson on how to make them succinct and informative.

**Summative assessment** : The gathering of information at the conclusion of a course, program, or undergraduate career to improve learning or to meet accountability demands. When used for improvement, impacts the next cohort of students taking the course or program. Examples: examining student final exams in a course to see if certain specific areas of the curriculum were understood less well than others; analyzing senior projects for the ability to integrate across disciplines.

**Criterion-referenced assessment** : A score that compares a student's performance to specific standards. The student is assessed in reference to some student outcome that can be expected as a result of an education experience (i.e., a degree of mastery of identified criteria. Criteria are qualities that can provide evidence of achievement of goals or outcomes, such as comprehension of concepts introduced or reinforced, a kind of inquiry behaviour encouraged, or a technique practiced for its potential contribution to the skill of the artist/student or the meaning/communication of the art work. It makes sense to assess in terms of what a teacher believes was taught.

**Alternative assessments** : A catch all term for assessments that depart from the traditional multiple choice, norm-referenced tests such as coding live art criticism discussions, portfolio reviews, rating performances or art products on criteria established by teachers and students, journals, authentic task assessment and direct observation of student performance.

**Authentic assessments** : Assessment that fits meaningful, real-life learning experiences. It includes recording evidence of the learning process, applications in products and performances, perception of visual and audio relationships, integrations of new knowledge, reflecting profitably on one's own progress, and interpreting meaning in consideration of contextual facts.

**Performance assessments** : An observation of the process of creating an answer or product that demonstrates a student's knowledge and/or skills. Directly observable, student-generated evidence of learning.
Developing Marking Schemes: Once an assessment tool has been settled on, specific decisions may have to be made about the criteria by which student work will be assessed, depending on the learning outcome being assessed and the tool for assessment. Choosing criteria is where rubrics come in.

A rubric is a set of criteria for assessing student work or performance. Rubrics are particularly suited to learning outcomes that are complex or not easily quantifiable, for which there are no clear "right" or "wrong" answers, or which are not evaluated with standardized tests or surveys. Assessment of writing, oral communication, critical thinking, or information literacy often requires rubrics.

Rubrics have two dimensions: they identify the various characteristics of the outcome, and they specify various levels of achievement in each characteristic. Thus, a well-designed rubric consists of:

- clear definitions of each characteristic to be assessed for a given learning outcome, and
- clear descriptions of the different levels of achievement for each characteristic.

Because rubrics establish criteria, they can help make assessment more transparent, consistent, and objective. Faculty members and evaluators can use rubrics to communicate to students and each other what they see as excellent work, while students gain an understanding of what is expected and how their performance will be assessed.

Rubrics are also useful when there is more than one evaluator; rubrics can serve as standardized scoring guides that assist different evaluators to determine the quality of student work in a consistent manner.

Giving Feedback: Feedback tells students how they are doing towards achieving intended learning outcomes. This information can help them to improve their learning and so help them to enhance their performance in assessment. There is also considerable research evidence that the most important part of the assessment process, with regard to supporting learning, is feedback.

Each unit in a programme should normally include not only summative assessment but also formative assessment for which suitable feedback is provided in time for students to learn from it before major summative assessment. Coursework often serves a formative purpose through feedback while also contributing to summative assessment through the marks awarded; in such cases, feedback should be returned in time to inform the next piece of coursework.

Selecting Teaching and Learning Activities (TLAs): Selecting teaching and learning activities aims to help students to attain the intended learning outcomes and engage them in these learning activities through the teaching process.

A student-centered approach is the emphasis in OBE as its success is largely dependent on the extent to which students take responsibility for their own learning and whether or not co-operative learning is used; this is because one of the long-term outcomes of OBE is usually related to generic skills and attitudes such as teamwork and co-operation. Therefore, programs and courses should also provide experiences that students are going to encounter in the real world. These activities can be teacher-managed, peer-managed or self-managed.

Biggs (1999) suggested the following points of guidance for planning teaching strategies:

- Sound knowledge is based on interconnections – connecting new learning with old. Encourage students to create conceptual structures which integrate their new and old learning.
- Develop meta-cognitive skills by being explicit about learning and maximising students’ awareness of their own knowledge construction through structured reflection
- Plan learning activities that actively involve students. Activity heightens arousal and makes performance more efficient
- Incorporate explicitly stated study skills into learning, and if necessary, provide support for developing skills, for example in teamwork
- Consider how information technology can support learning and teaching.

Reviewing your Program Level Outcomes
Number of outcomes: Keep the number manageable; 10-20 outcomes are probably the acceptable range. Address intermediate outcomes at a year or course level.

Check for overlap: Easily differentiable from each other. This is particularly important if you are going to map your curriculum.

Check for clarity: Communicate clearly to students about what they need to achieve in the programme (i.e. it would give them a clear direction for their study).

Check for representativeness: Informs reader of attributes found in a graduate from the programme.

Check for alignment: Alignment of outcomes at different levels: School, Program, Course. Alignment between ILOs, assessments and teaching and learning activities. Alignment with the University’s graduate attributes (ABC LIVE) to produce all-round students with academic and professional competence.

Writing Intended Learning Outcomes: Intended learning outcomes need to be written at both program and course levels. Both of them need two essential elements:

A statement of what content are the student is expected to be able to do at the end of learning experience. The levels of understanding or performance in those content areas.

Program Learning outcomes: The accreditation Board for Engineering and Technology (ABET) defines Program Learning Outcomes as "statements that describe what students are expected to know and be able to do by the time of graduation." To get started, the school must develop a list of learning outcomes derived from, or consonant with, the School’s mission. The mission and objectives set out the intentions of the School, and the learning goals say how the degree programs demonstrate the mission. That is, the learning outcomes describe the desired educational accomplishments of the degree programs.

Course Learning outcomes: Course Learning Outcomes describe the complex performances a student should be capable of as a result of learning experiences within a course. These are determined by the course instructor, or, in the case of a course with several sections, by a team of instructors who teach the same course.

Choosing appropriate action verb: In the process of writing learning outcomes, the curriculum team would use associated action verbs for different levels of learning. The use of action verbs facilitates alignment of program and course learning outcomes and course learning outcomes with assessments. When writing program learning outcomes, anticipate how student learning will be assessed in relation to each expectation. Vague verbs such as know or understand are not easily measured and need to be substituted with performative verbs such as identify, define, describe or demonstrate. Some of these verbs are listed in the table for consideration. In the early years, lower level cognitive outcomes, i.e. "Remembering", "Understanding" are given stronger emphasis. The level moves upwards as the years move on. Higher level outcomes like "Evaluating" and "Creating" would have more emphasis in later years. It is a curriculum team’s responsibility to ensure this developmental progression over the program and to make sure the four types of intended learning outcomes are covered appropriately.

<table>
<thead>
<tr>
<th>Levels of Learning</th>
<th>Action Verbs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 6: Creating</td>
<td>Create: generating, planning, producing, composing</td>
</tr>
<tr>
<td>Level 5: Evaluating</td>
<td>Evaluate: checking, critiquing, assessing, concluding</td>
</tr>
<tr>
<td>Level 4: Analysing</td>
<td>Analyze: differentiating, organizing, attributing, comparing, outlining</td>
</tr>
<tr>
<td>Level 3: Applying</td>
<td>Apply: executing, implementing, classifying, calculating, constructing</td>
</tr>
<tr>
<td>Level 2: Understanding</td>
<td>Understand: interpreting, exemplifying, classifying, summarizing, inferring, comparing, explaining</td>
</tr>
<tr>
<td>Level 1: Remembering</td>
<td>Remember: recognizing, recalling, describing, listing</td>
</tr>
</tbody>
</table>
Choosing an appropriate tool and method

1. Design assessment methods that are aligned with the overall aim of the program
2. Ensure that they have accounted for any requirements set by professional bodies
3. See that your assessment tasks are aligned with the stated learning outcomes
4. Use assessment methods that best measure achievement of the stated learning outcomes
5. Be fair in how much you ask of your students and how much value you assign to each task
6. A variety of assessment methods is employed so that the limitations of particular methods are minimised and take account of the diversity of students
7. There is provision for student choice in assessment tasks and weighting at certain times

A Variety of Tools and Methods is needed because:

- In order to achieve constructive alignment and validly assess all of the outcomes
- Traditional assessment only assess a fairly narrow range of skills and with the current expectations to develop students as lifelong learners with a range of transferable and disciplinary skills, a narrow range of assessments is unlikely to be able to assess validly on a wide range of outcomes
- A variety of assessment offers all students disadvantaged under one the opportunity to possibly excel in the others
- Borden range of assessment methods means more choice and variety for students. These are the two factors that can increase interest and motivation
- To develop students' competencies
- To take a holistic approach on assessing students' performance

Example of an OBA Marking Scheme

Here is an example of a constructively aligned assessment scheme:

<table>
<thead>
<tr>
<th>Objectives</th>
<th>Grading Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grading will be based on you attaining the</td>
<td>Grades will depend on how well you can demonstrate that you have met all</td>
</tr>
<tr>
<td>following criteria:</td>
<td>objectives:</td>
</tr>
<tr>
<td>Demonstrate appreciation and understanding of</td>
<td>A: Awarded if you have clearly met all the objectives, displaying deep knowledge</td>
</tr>
<tr>
<td>the delicate balance in the environment.</td>
<td>of the content, creative thinking, applying the concepts effectively to new</td>
</tr>
<tr>
<td>Demonstrate understanding of sustainability</td>
<td>B: Awarded when all objectives have been met well and effectively</td>
</tr>
<tr>
<td>and related issues in the environment.</td>
<td></td>
</tr>
<tr>
<td>Have knowledge of relevant UK and EU</td>
<td>C: Awarded when the objectives have been addressed satisfactorily, or where</td>
</tr>
<tr>
<td>environmental legislations.</td>
<td>evidence is strong for some objectives, but weaker in others.</td>
</tr>
<tr>
<td>Reuse specific pollution control technologies</td>
<td>F: Less than C, or work not submitted</td>
</tr>
<tr>
<td>to industries.</td>
<td></td>
</tr>
<tr>
<td>Appreciate the range of engineering related</td>
<td></td>
</tr>
<tr>
<td>environmental problems.</td>
<td></td>
</tr>
</tbody>
</table>
References: