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# Outcome Based Education and Revised Bloom's Taxonomy as a Catalyst for Redesigning Teaching and Learning in Engineering Education

**Dr. V Evelyn Brindha**
Professor, EEE, Karunya Institute of Technology and Sciences,
Karunya Nagar, Coimbatore, Tamil Nadu, India.
evelynbrindha@karunya.edu

**Abstract :** In present days an engineers' requirements are growing as swiftly as the technologies that participate for their attentions. At the same time, our policies and systems are lengthened to their confines to keep up with the varying demands of the times. There is, particularly, a must to protract reflective amalgamation of social and technical knowledge into the upcoming generations of engineering, to create more humane engineers, to enable them to create technological solutions that are more human-centric. Addressing such desire necessitates new approaches to designing engineering courses and teaching them as well. Every encroachment in the education sector from here onward entails a new prototype that can be used in large-scale methodical transformation of education: Outcome Based Education (OBE). This paper delineates the means to use OBE as the foundational means for transforming engineering education. Inclusion of skills to innovate new ideas, Metacognitive skills and professional skills are endorsed, and collaborative, inquest driven practices are motivated to craft and protract novel ways of thinking, interacting, teaching, learning and working. An OBE framework in education is the alignment of Curriculum, teaching practices and Assessment carried out in an institute. OBE apart from enhancement of students' thinking abilities it furthermore helps in standardization of education, curriculum enrichment, meeting out the accreditation and industry needs and augmenting the need for continuous improvement.

**Keywords :**Outcome Based Education; Andragogy; Heutagogy; Formative assessment; Micro teaching; Micro planning

## 1. Introduction

Several studies and reports have described the need for improvement in present engineering education [1, 2, 3, 4]. Deprived teaching by engineering faculty has been publicized to be a causative factor to student attrition from engineering [5, 6, 7], understanding the attitudes, beliefs and performance of faculty who are dedicated to teaching may endow with ideas to improve engineering education in general. Even though teachers embrace popular beliefs about what composes an effective teaching, a number of researchers have conducted studies to endow with data to speculate these beliefs. In this paper, I discuss the methodology used to implement OBE framework in education and provide the preliminary results of this study. Unswerving with common intuition that teaching is an art, our data reveals that faculty must employ multiple, overlapping teaching practices and assessment methods to advance the attention span of the millennial generation students. However, there are some agreements in the teaching practices reckoned to be very important. This paper presents and discusses

**Dr. V Evelyn Brindha**
Professor, EEE, Karunya Institute of Technology and Sciences,
Karunya Nagar, Coimbatore, Tamil Nadu, India.
evelynbrindha@karunya.edu

about the top-ranking ideas for "Innovation in Teaching and Learning methods" they are 1) Collaborative classroom environment 2) Strategies accentuating student meta-cognitive/ self-regulated learning and 3) Strategies highlighting student perception of learning. Andragogy, the art and science of adult teaching, provides the basis for deep and significant student learning. Across the globe, faculty members are employing an array of instructional approaches designed to foster teaching excellence. The development of this student-centered instructional methods results in engaging students in critical thinking, self-awareness, and global citizenry.METHODOLOGY

Outcome Based Education (OBE) and Revised Bloom's Taxonomy (RBT) is used as a catalyst to improvise students' participation in classroom hence enhancing the teaching learning process. The OBE framework begins with the Mission and Vision of an Institute, which in turn defines the mission and vision of a department/school. This statement of vision and mission defines the Program Educational Objectives (PEO) of a department. These PEO's are mapped with the Program Outcomes (PO's) as defined by the graduate attributes and the Program Specific Outcomes (PSO) pertaining to specific outcomes of an Institute or department. Each subject in the department are defined with Course Outcomes (CO) and attainment of these CO's are mapped with the overall attainment of the program in the OBE framework. An apparent step by step process described in this paper helps in achievement of CO's pertaining to a subject. Apart from attainment of CO's these methods also help in making classrooms lively and interactive.

Outcome Oriented Learning Framework (OOLF)

Every teacher needs to prepare an OOLF which is the teaching plan for handling the course. This OOLF is prepared with the help of Revised Bloom's Taxonomy (RBT). An OOLF consists of General objectives and Specific Outcomes. General objective (GO) is a single statement that define the overall plan of teaching for a single class. A GO is written with the help of RBT. Any topic can be taught to any of the six cognitive levels such as Remember, Understand, Apply, Analyze, Evaluate and Create and it can be mapped with the four types of knowledge domain such as Factual Knowledge, Conceptual knowledge, Procedural Knowledge and Metacognitive knowledge. Hence a GO is a statement that defines the level to which a topic is taught to the students. These GO is further defined into Specific Outcomes (SO's). As the name implies specific outcomes splits the GO into smaller steps of teaching the topic. An ideal one hour of class can have 4-5 SO's and these SO's also should be mapped with the cognitive and knowledge domain of the Revised Bloom's Taxonomy. A sample mapping of the above-mentioned process is given in the Table 1.1.

By doing this the faculty gets a clarity as to which level each topic is to be taught and this will also give a guideline as to which level the students are to be questioned in the summative evaluation. For instance, if a topic is taught in the class to the analysis level, the questions pertaining to the topic should be anywhere between remember to analysis and not more than that level. A sample GO, SO and RBT mapping table is given below.

General Objective:

At the end of the class students will be able to analyze and design simple combinational logic circuits used for various purposes such as arithmetic operation, code conversion, data transmission, error detection during transmission and magnitude comparison.

Specific Outcomes:

At the end of the class students will be able to

1. Interpret the truth table and Boolean expression of half & full adder and half & full subtractor circuit using k-map.

**Table 1.1: Revised Bloom's Taxonomy Mapping**

| TOPIC WISE LEARNING OUTCOME MAPPING | | | | | | |
|---|---|---|---|---|---|---|
| Knowledge Dimension | The Cognitive Process Dimension | | | | | |
| | Remember | Understand | Apply | Analyze | Evaluate | Create |
| Factual Knowledge | | | | | | |
| Conceptual Knowledge | | **1,2** | | | | |
| Procedural Knowledge | | **3** | | **4** | | |
| Meta Cognitive Knowledge | | | | | | |

2. Construct the circuit for full adder and full subtractor circuit using logic gates.

3. Exemplify the conversion between Binary, gray code and BCD using k-map.

4. Justify the need for using gray code over binary codes in error correction.

The Table given above is a sample RBT mapping table that clearly maps the learning objectives of a one-hour class with the cognitive and knowledge domains. As per the mapping table the topics defined in SO's 1 and 2 are Conceptual knowledge taught to the understand level, whereas topic 3 is procedural knowledge taught to the understand level but topic 4 is also a procedural knowledge taught to the analysis level which is comparatively a higher level. This decision on the level of teaching a topic depends on the importance of the topic for teaching the entire subject, level of the students, semester in which the topic is taught, the prerequisite knowledge of the topic and so on. Apart from preparing an exhaustive OOLF for every class, teachers should also adopt various innovative engaging methods in classes to effectively engage the millennial and generation students.INNOVATION IN TEACHING AND LEARNING

"If we teach today's students as we taught yesterday's, we rob them of tomorrow"

The innovation in teaching and learning can by broadly categorized into 3 areas.

1. Innovation in Instructional Practices

2. Innovation in Formative Assessment

3. Innovation in Evaluation

1. Innovation in Instructional practices: Nowadays all classrooms are highly equipped with ICT facilities such as laptops, Projectors and speakers. These facilities enhance faculty members to employ various tools to teach a topic in classrooms. This paper is highlighting few methods to implement a great paradigm shift from teacher centered to student centered classrooms in which teachers are guide on the side and not sage on the Stage. One hour of teaching would have various activities which involve students rather than making them sit as passive listeners. To be specific the various practices followed are as follows.

2.1 Evocation

Taking into consideration the primacy effect of our human psychology, the topic to be taught in that hour is introduced to the students using various methods such as discussing the history of the topic, quoting applications relevant to the topic, extracting videos and images for inculcation of auditory effect, citing from newspaper cuttings and referring relevant topics using google doodle, relating an analogy, role play by students etc.,

2.2Microplanning

A fifty minutes classroom teaching is split into a minute by minute plan and it is customized by the individual teachers depending on the subject and level of students being taught. A sample of the Micro planning has been shown in Figure 1. The example shown is the microplanning of a one-hour class that has one GO, four SO's and two Formative Assessments (FA).

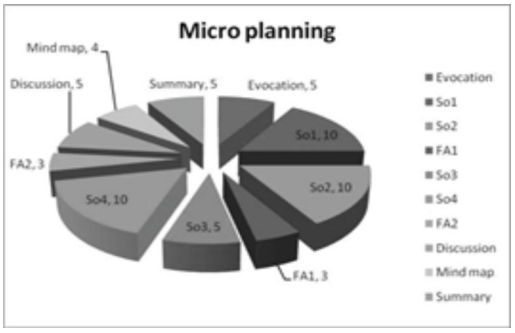


**Fig. 1: Microplanning**

2.3 Classroom discussion and Mind Mapping

Students are made to sit in groups and are given a topic for discussion and at the end of the discussion they are requested to make a presentation or write a journal on the outcome of the discussion. A mind map is a method used to visually arrange information. A mind map is hierarchical and shows relationships among pieces of the whole [8]. It is often created around a single concept, drawn as an image in the center of a blank page, to which associated representations of ideas such as images, words and parts of words are added [8]. Major ideas are connected directly to the central concept, and other ideas branch out from those [9]. It helps the students to use both the sides of the brain [9] and it also helps them to recall information's taught in the class. A sample mind map is shown in Fig. 2.

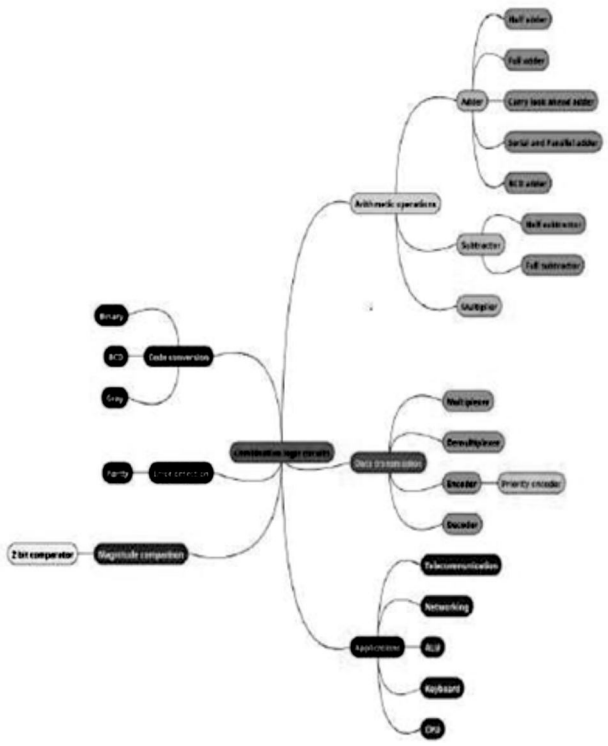

**Fig. 2: Mind map**

1.4 Jigsaw method

The Jigsaw method is a technique that makes students reliant on each other to accomplish success [10]. It splits students into groups and breaks assignments into pieces that the group assembles to solve the (jigsaw) puzzle. The method divides classes into mixed groups to work on small problems that the groups collate into a final outcome.

1. Innovation in Formative Assessment

Goal of formative assessment is to gain an understanding of what students know (and don't know) in order to make responsive changes in teaching and learning, techniques such as teacherobservation and classroom discussion have an important place alongside analysis of tests and homework [11]. [12] Encourage teachers to use questioning and classroom discussion as an opportunity to increase their students' knowledge and improve understanding. Hence formative assessments are done very frequently in classrooms. For conducting formative assessment free tools such as Flubaroo and Plickers can be used.

2.1Flubaroo

Flubaroo is a FREE add-on to Google Forms/Sheets which lets teachers quickly grade and investigate student performance on multiple choice and fill-in assignments. We can also share scores through mail with students, along with optional notes to the class and/or to each student.

2.2Plickers

This is a powerful tool that lets teachers collect real- time formative assessment data without the use of any gadgets or devices by students. It is a on the go process which requires very nominal or even zero preparation time for the teachers.

## 3. Innovation in Evaluation

In order to exhibit Whole Person Education (WPE), students will have to be evaluated through various means. Hence the level of students can be evaluated not only through formative and summative assessments. But can evaluate their abilities through various other methods and some of them are discussed below.

3.1Cross over evaluation

Students are evaluated based on their involvement in extension activities which cross link with the subjects and helps students to find solutions to human problem especially in the areas of food, water, health-care and energy. They are graded based on their levels of involvement and it is made mandatory for every student to acquire a minimum score in extension activities. The academic calendar is inculcated with Non-Academic Saturdays which are meant for carrying out these activities.

3.2Qualitative evaluation

Every subject has a maximum of 3 qualitative assessments and it is left to the choice of the faculty to conduct these qualitative assessments. The various quality assessments in practice are library-based assignments; innovative presentation on the recent topics, quiz, group discussions, etc. The mark scored in this evaluation process becomes a part of the internal assessment marks

## Results And Discussion

A questionnaire-based course exit survey for the subject Digital Electronics was conducted among 150 students consisting of 70 male students and 80 female students, doing their second year Electrical Engineering course and the results of the survey has been presented here. Figure 3 portrays the results of usage of GO and SO. Fig. 4 illustrates the consequences of using mindmap as a teaching tool, Fig. 5 shows the results for innovation teaching practices used in classes such as jigsaw method that enhances peer learning and Fig. 6 reveals the fact that formative assessments using tools such as Flubaroo and Plickers enriches learning. The domino effects of the survey are found to be promising and it declares that these methods when followed in classrooms will definitely improve the teaching learning process in an engineering education.

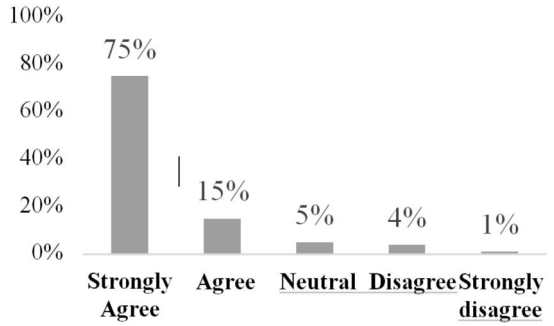


**Fig. 3: GO and SO in classroom teaching improves clarity**

(i) GO and SO in classroom teaching improves clarity:

From Figure 3 it is evident that inclusion of General objective (GO) and Specific Outcomes (SO) in classroom teaching helps students in getting a better clarity of the topic handled. 75% of the students have strongly agreed for the same.

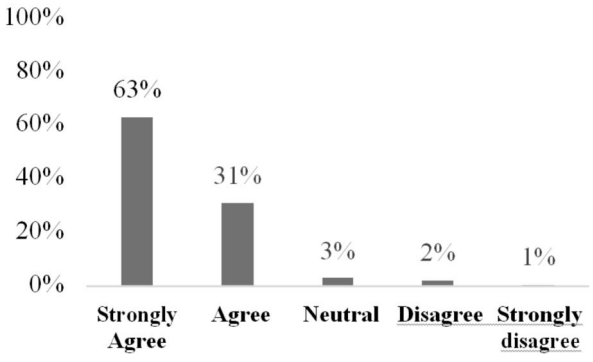


**Fig. 4: Mind map to recall information**

(ii)Mind map helps students to recall information:

From Figure 4 it is apparent that usage of mind mapin classroom teaching is appreciated and strongly agreed by 63% of the students and as a teacher the impact of it is huge in helping students to recall the information at a later stage.

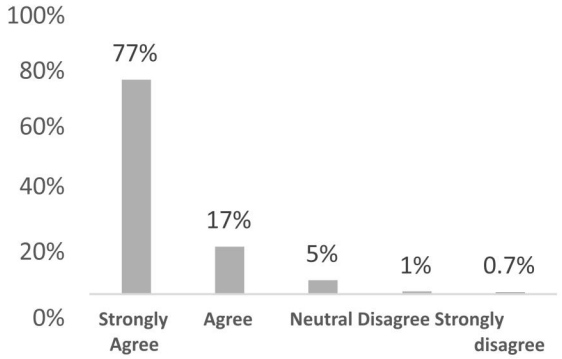


**Fig. 5: Innovation in teaching increases peer learning**

Innovation in teaching increases peer learning

From Figure 5 it is specious that usage of innovative teaching methods such as jigsaw method in classroom had attracted and is strongly accepted by 77% of the students. This makes the entire class to become student-centric rather than teacher-centric.

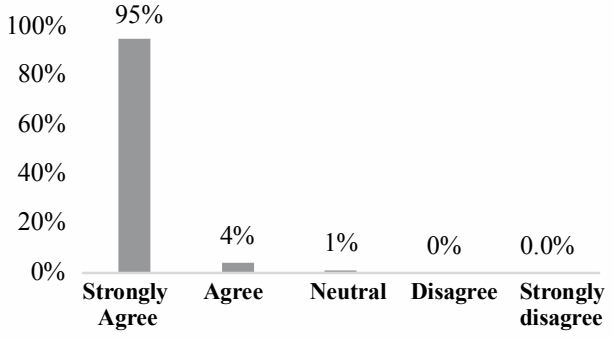


**Fig. 6: Formative assessment enhances learning**

(iii)Formative assessments using tools enhances learning:

From Figure 6 it is ostensible that conduction of formative assessment using online free tools such as Flubaroo and Plickers enhances the learning and makes the entire activity enjoyable by 95% of the students.

## Conclusion

Thus, teaching by describing general objectives and specific outcomes gives a complete clarity in teaching and learning process both to teachers and students. Having an organized set of outcomes and mapping them in a Revised Bloom's Taxonomy table given a lot more clarity for the faculty to plan an alignment between the cognitive level of teaching and cognitive level of assessment. It aids teachers to: "design and deliver appropriate instruction"; "plan valid assessment tasks and strategies"; and ensure that student-centric learning happens in classrooms." It also ensures self- learning, peer-learning and group learning. Hence this paper concludes that Outcome Based Education and Revised Bloom's Taxonomy not only gives a rigid plan for teaching but also definitely acts as a Catalyst for Redesigning Teaching and Learning in Engineering Education.

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