OBTL: An Experimental Approach in Engineering Education

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***Abstract*—Engineering education is one of the most demanding courses compared with many degree programs. In the recent times, many educators in the field of engineering education and teaching have been in the approach of recommending redesign of the curriculum and restructuring the engineering education system according to Outcome-Based Training and Learning (OBTL) Approach. However, the issues related in defining the objectives and assessing the outcomes in OBTL is challenging among the most of the teachers who are not basically trained for setting up objectives and evaluating the results. This paper presents a brief introduction of OBTL and how it can be practiced from the engineering education program design perspective. In this paper, our view of initial attempt in designing and developing engineering education curriculum using OBTL will be shared. Based on the OBTL paradigm, we evaluate teaching impact, effectiveness and student learning outcomes based on the training assessment results and their success. Through deeper understanding and learning, OBTL approach in engineering education can bring a drastic change and create greater impact on students and make them prepared for exciting career and brings out more eminent engineers who can steer the world to the development.**

Keywords—Outcome-Based Training and Learning; teaching evaluation; engineering education; curriculum; Learning Outcomes;

I. INTRODUCTION

The Outcome-Based Training and Learning approach education in the present day scenario has become a major focus in training and learning enhancement of engineering education. From the past few years, some of the deemed universities and autonomous educational organizations have stressing the importance of unfolding the outcome-based framework in both designing of curriculum, teaching and learning pedagogy of engineering education. Yet, the concept of Outcome-Based Teaching and Learning is not a new concept of education evolution.

In the present day scenario of imparting the technical concepts of engineering education, both theory and practical contents are driven by the need and demand of skilled engineers for industries day by day. A course of engineering program today is all about teaching students theoretically more about a practical oriented subjects with zero percent practical's, for example DotNet in Computer Science, Power Systems and Basic Simulation in Electrical and Electronics Engineering, Embedded Systems in Electronics and Communication Engineering etc. It is very rare to have a tight cohesion with what a student is expected to gain at the end of technical degree. A question is that, should the educators simply impart the related topics to students so that the students know only the principle and working mechanism of it theoretically. Or expect the students to be able to know the working of it experimentally and will be able to create a sustainable real time systems. Perhaps the students can complete course with high grade or percentage of marks because of just simply knowing the course subjects theoretically, but not able to know how to design a real time system to get a solution for a specific problem. Unless, in teaching and training of the student, the outcomes of the course and the program are presented precisely to the students, the entire course can become unworthy. And what is taught plays no meaning if a certain ability of students is not expected at the beginning and end. That is the reason; the "Outcome-Based Training and Learning Approach" is to be brought into view and to be introduced, particularly in the field of engineering education at all levels of programs in all the universities and private engineering colleges specifically in the Indian engineering educational curriculum today. Experiential learning is also referred to as learning through action, learning by doing, learning through experience, and learning through discovery and exploration, all which are clearly defined by these well- known maxims:

I hear and I forget, I see and I remember, I do and I understand.
~ Confucius, 450 B.
Tell me and I forget, Teach me and I remember, Involve me and I will learn.
~ Benjamin Franklin, 1750.
There is an intimate and necessary relation between the process of actual experience and education.
~ John Dewey, 1938.

To guarantee that students achieve certain real time skills. At the engineering education programs curriculum design needs to be as specific as possible so that the objectives of the program are reached. With this approach of Outcome–Based Training and Learning approach it could be easier to reach out the objectives and lead in the development of science and technology.

II. MOTIVATIVES

Firstly, as of now in engineering educational programs in Indian universities and colleges, OBTL doesn't exist till now in curriculums. OBTL is a methodology which mainly concentrates on what students are expected to learn, implement in real time and how it becomes measurable through assessment. At the initiation the two major tasks are the vital components in this OBTL. The first focused on student's expectation that is what they will be able to do after completing the course of a program. In designing the curriculum of the program, a set of outcomes are considered to be mapped to all the courses under the engineering educational program. Next is to focus on the preparation of the learning outcomes. Bloom's taxonomy of the cognitive domain frame work is widely and mostly used in the design and assessment of other courses. Yet, this system is found not exactly suitable to engineering education. Because of different reasons compared with other fields of education. However Clearly, Bloom's Taxonomy has faced a toughest test of time. But due to its previous lasting history and popularity, it has been concise, expanded, and once again elucidated in many ways. Heading with the tough time, Research findings led to discovery a wide variety of interpretations and applications falling on a continuum ranging from tight overviews to expanded explanations, made suitable to engineering education to interpret the learning outcomes.

Once it is over, the next important task is to state how the students will learn, or the teaching and learning activities, which leads to the assessment procedures as managing learning outcomes. The assessment using OBTL can offer some meaningful feedback to the teachers regarding student's achievement and the quality of the instruction.

Surprisingly even today most of the technical educators follow time saving normal referenced assessment. Students were also encouraged to perform traditional learning methods such as theoretical question and answer based learning. The effectiveness of this approach may not be known at the moment of usage. We strongly believe that it is a true education when the teachers turn teaching to a student centric approach imparting more skills in the fields involving them in theory, research and implementation.

III. OUTCOME-BASED TRAINING AND LEARNING APPROACH CURRICULUM

A. OBTL Framework

OBTL is an approach to design curriculum where teaching and learning mainly focus on, what the students are expected to do, rather than what the teacher expects to teach. The objective of curriculum is shifted to the student centric approach, the assessment leads to a Criteria Referenced Assessment (CRA) based practically instead of normal referenced assessment. CRA concentrates on the expectation of students learning skills they should have to obtain a degree.

B. OBTL Curriculum Design Example

Engineering programs is to be designed as an industry ready oriented approach so that students are expected to learn skills which are essential to their future jobs. For example if a student wants to become a software developer they should be able to write programs for the real time problems using different programming languages at the end of completion of the degree. For any program at the beginning it should clearly specify the learning outcomes and objectives of the program. For example:

i. Focus on Objectives: Computer Science and Engineering program to be designed to meet the following.

- To incept and develop student's ability in programming, designing systems and developing logics.
- Provide an environment to increase student's capability and confidence for independent thought and creativity.

ii. Objectives of curriculum are:

- Provide students with the knowledge and techniques to effectively design and manage software and hardware projects, and to be able to aim a career in related field.
- Students need to undergo a professional training so that they may acquire the ability to adapt to different development working environments in the industry.
- Provide students with the sound basic knowledge with logical thinking for further technical and career development and qualification to enable them to go for higher qualifications, locally or abroad.
- Promote students capabilities in communications, social awareness and moral responsibilities. In addition, to this there are more objectives that are relevant, a graduate or a postgraduate should acquire knowledge and skills in computer programming, networking, security, operations and management.

iii. Course Components:

Sound fundamental, elementary design structures, analysis of present systems, and mathematical implementations to be taught. With the introduction of all the key basic building blocks engineering with respect to a specific program should be imported at the inception of every course, along with emphasis shifting from fundamentals to a professional perspective and to industry standards.

In course of program students need to study more advance technological development concepts and techniques. At the end of the course, students should acquire techniques for developing real time systems.

Prior to acquiring engineering graduation or post graduation degree, students need to be assigned with two or more projects to gauge the overall culmination of knowledge of developing real time systems, understanding, and technical skills that they have acquired during the course study of a program. At end students should be capable of analyzing, design, and develop real time implementable systems with their level of competence and to industry standard.

iv. OBTL Teaching & Learning Activities:

During the course of a program, it emphasize that lectures,

seminars, guest talks, case studies and mini-projects need to be provided to students so that they are bestowed with the opportunities to learn from real time examples. This helps them to develop working systems. Students need to be encouraged to think independently and apply their thoughts in accomplishing specific real time problems. To achieve this, student need to be encouraged to adopt and active knowledge seeking attitude and to increase and strengthen their own confidence and ability to communicate and work with the team.

Based on the nature of the course subjects, all or some of the different training and learning approaches like lectures, tutorials, seminars, guest talks, industry experts interaction, case studies and monthly assignments regarding project developing exercises can be employed. During this students will be encouraged to raise queries on the subject matter and participates in short discussions. Lectures are to initiate and reveal concepts, express how to illustrate and analyze an issue. Develop student's capability to think independently. Case study (i.e. the case analysis of an application) enables the students to examine, analyze and solve problems of the real world and practical problems of the industry. Guest talks and industry experts may be invited to interact with the students to share their up-to date technical knowledge. Students are encouraged and well supported to carry out self projects and team works to apply the knowledge they gained from the learning process. Problem solving skills are developed by applying a range of techniques and ideas in handing real world problems in engineering. In this method Instructions are designed to engage students in experimental experiences which are tied to real time problems and situations existing at present in the world in which the instructor facilitates rather than directs student progress. All the above training and learning approaches will create a learning environment in which students play an active vital role with self motivated attitude.

C. Courses and Program Assessment System

At every program level, the OBTL suggests that all the course learning out comes should point to the objective outcomes of the course of an engineering program. At this level the difficulties may be facing is whether the learning outcomes can be met by all the courses of a specific program. Basic idea is to make use of system Bloom's Taxonomy for assessment. It is a hierarchical model of classifying thinking based on six cognitive levels of complexity. For the years, the levels have often been illustrated as a staircase way, guides many teachers to encourage their students to "climb to a higher thought." The lowest three levels are: knowledge, comprehension, and application. The highest three levels are: analysis, synthesis, and evaluation. "The taxonomy is hierarchical; each level is subset by the higher levels. Which means, a student functioning at the 'application' level has also mastered the content at the 'knowledge' and 'comprehension' levels?

IV. LEARNING OUTCOMES AND MEASUREMENTS

The objective in OBTL is to transfer the paradigm from teachers centered approach to student centered approach. That's the learning outcomes need to reflect what students are expected to gain and able to do at the end of the course.

The mechanism of bringing out the effective learning outcomes depends on the right verbs used in the statements; Bloom's taxonomy is commonly used for defining learning outcomes, which give the benefits of its ready-made structure and list of verbs. The verbs in Blooms taxonomy are measurable. For example, one of the learning outcomes in a course can be, "Upon the completion of the course, students should be able to develop a group project of a real time application system". A good quality assessment activity can be to a group project approach. If a group of students can work together to develop a system, then we can confirm that the students have achieved the one of the learning outcomes. Further, individual evaluations can confirm if each of the students have made an appropriate contribution to the project.

A poor example of learning outcomes can be, "Upon the completion of the course, students will be able to know only the theory knowledge even without knowing the practical working of the present system. In such case, the student assessment is very difficult to measure. In other words, the understanding of knowledge cannot be reflected by any mean as a student can simply respond with a feedback at the end which is not at all an appropriate assessment in the engineering education.

Engineering programs must demonstrate that their students attain the following outcomes:

- Ability of applying knowledge of mathematics, science, and engineering
- Ability to design and conduct own experiments, and also to analyze and interpret data.
- To acquire an ability to construct new a system, or component, or process to meet the required needs within realistic constraints.
- Multidisciplinary team functioning.
- Ability to recognize, formulates, and solves technical problems.
- Professional and ethical responsibility understanding.
- Ability to communicate effectively
- Ability to interpret the importance of engineering solutions in the real world context.
- Recognizing the need of life-time learning
- Expertise to grasp Knowledge of current day issues.
- Get prepared to use the techniques, skills, and latest advanced engineering tools necessary for engineering practice.

Technical-Based Knowledge Systems (Bloom's Taxonomy).

TABLE 1.

Aims	Learning Outcomes
Creating	Putting elements together to form a new functional system or reorganizing elements to form a new pattern.
Evaluating	Judge based on criteria and standards by checking and critiquing.
Analyzing	Slicing material into constituent parts, identifying how the parts relate to each other and to the entire system.
Applying	Implementing a procedure through executing.
Understanding	Developing meaning from oral, written, and graphic messages by interpreting, classifying, summarizing, comparing, and explaining.
Remembering	Retrieving, and remember relevant information from long-term memory.

V. CONCLUSION

It creates a better training and learning and environment where all the activities can reflect the worthiness of the skills the students acquired. Assessment of the training and learning outcomes becomes very precise, because students know what they need to learn and do upon acquiring the degree. Students feel their progress in flourishing intellectual skills through the course as the outcomes and objectives are precisely stated in the program course syllabus. It offers an intuition that the outcome- based training and learning approach can enhance teaching and learning in overall performance among the engineering program of study.

OBTL is indeed going to be a promising direction in our education system such that student outcomes are being the driving force and inspiration of teaching and learning. With this we believe that students will continue to be trained and become potential future leaders of the industry.

REFERENCES

[1] Outcome-Based Assessment Data to Improve Assessment and Instruction: A Case Study," ACM SIGTIE Newsletter, Vol. 3, No. 1. Spady, W., "Outcome-Based Instructional Management," The Australian Journal of Education 26(2), 123-143, 1982.

[2] Fuller, U., et. al., "Developing a Computer Science-specific Learning Taxonomy," in the Proceedings of ACM ITiCSE'07, pp: 152-170, 2007.

[3] Pang, M., Ho, T. M., and Man, R., "Learning Approaches and Outcome-Based Teaching and Learning: A Case Study in Hong Kong, China,"Journal of Teaching in International Business, 20:106-122, 2009.

[4] Khalifa, M., and Lam, R., "Web-Based Learning: Effects on Learning Process and Outcome," IEEE Transactions on Education, Vol. 45, No. 4, November 2002.

[5] Bouslama, F., Lansari, A., Al-Rawi, A., and Abonamah, A. A., "A Novel Outcome-Based Educational Model and its Effect on Student Learning, Curriculum Development, and Assessment," Journal of Information Technology Education, 2, 203-214.

[6] Swart, A. J., "Evaluation of Final Examination Papers in Engineering: A Case Study Using Bloom's Taxonomy," IEEE Transactions on Education, Vol. 53, No. 2, May 2010.

[7] Rigby, S., and Dark, M., "Using Outcomes

[8] Cooper, S. Cassel, L., Cummingham, S., and Moskal, B., "Outcome-Based Computer Science Education", ACM SIGCSE 2005, February 23 - 27, Missouri, USA.

[9] Zweben, S., Reichgelt, H., and Yaverbaum, G., "Outcome-Based Computing Accreditation Criteria," ACM SIGCSE 2006, March 1 - 5, Texas, USA.

[10] Yaverbaum, G., Reichgelt, H., Lidtke, D., and Zweben, S., "Outcome-Based Computing Accreditation: Program Assessment," ACM SIGCSE 2007, March 7 - 10, Kentucky, USA.

[11] Impagliazzo, John, "Using an Outcome-based Approach to Assess Computing Programs," ACM ITiCSE 2007, June 23 - 27, Scotland, United Kingdom.

[12] Au, O. and Kwan, R., "Experience on Outcome-Based Teaching and Learning," ICHL 2009, LNCS 5685, pp. 133 - 139, 2009, Springer-Verlag Berlin Heidelberg.

[13] http://www.foundationcoalition.org/fcsearch/index.html.