

Outcome Based Education: strategies and tools for Indian scenario

Co-operative learning

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Abstract— Engineering education is a way of teaching the future engineers the required skill sets and the knowledge for a lifetime after graduation. In the recent past due to advancements in technology, the internet media and social networking the education system is seeing a sea of changes in the innovative methods of teaching learning process. Rapid development in information technology and global economy has led the present day engineers to perform in a global market which demands for more competitive and challenging roles. In this regard, this research looks at the role of the faculties in transforming education for the upcoming engineering graduates. The research discusses the challenges that come across in this transformation from a traditional teaching- learning environment to an outcome based education system. The results of adapting to the new tools in engineering education has shown encouraging results and has given rise to a congenial environment for both faculty and students.

Keywords— OBE; Technology; Mechanical Engineering OBE;

I. INTRODUCTION

Engineering as a profession involving challenges in design, manufacturing and development of new systems. These systems have to be reliable, environmental friendly, cost effective and should have wide applications. Development of such robust systems need well trained engineers. Today, a fresh engineering graduate is expected to meet the needs of the industry and society at large with good engineering and communication skills. Thus, engineering education plays a vital role in educating the engineers of the future. An engineering institute today faces a challenge in doing so because the curriculum designed for an engineering graduate tends to become outdated if it relies only on specific technologies. More laboratory based experiments in fields like thermodynamics can prove very effective for a graduate if the faculty engage them in the learning process with updated technology [1]. The fast changing world of today has influenced the industry to roll out a new technology or adapt to a new technology at a very fast rate. Any industry which will not adapt fast will perish fast. There are many case studies which show that faster

adaptation to technology has yielded better growth where teacher's role is as a researcher in the class [3].

Engineering education research is fast gaining importance because of the challenges it faces in the rapidly changing dynamic environment. To keep abreast with the changing technologies the engineering education in India is compared to the education system globally. For a country like India, the transition from traditional teaching to outcome based education can be achieved by following the mandates by quality assurance and monitoring committees like National Board of Accreditation (NBA), India and National Assessment and Accreditation Council (NAAC). This paper discusses few models and challenges for Indian engineering education aiming for Outcome Based Education. There are many strategies that can help students and faculty to practice Outcome based Education. Some of these are discussed here.

II. OUTCOME BASED EDUCATION STRATEGIES

A. Getting ready for Accreditation

National Board of Accreditation focuses on setting the vision, mission, and objectives on the basis of outcomes that is expected out of the programme. The accreditation is carried out for each programme. This highlights the necessity for providing engineering education with quality and employability. Figure 1 shows the connectivity of the Programme Outcomes is expected to achieve the mission and thereby fulfilling the Vision of the programme and the vision of institute in turn. This is represented in the form of a pyramid structure which shows the overall achievement of Vision from Programme Outcomes.

The various tools used to assess the programme outcomes form the base of the pyramid which can include maximum number of tools. These programme outcomes should be designed in such a way that maximum number of tools can be accommodated while measuring the outcomes. The Programme Outcomes are measured in a broad sense measured through Course Outcomes which will give an in depth analysis of the programme. The Programme

Outcomes and Programme Educational Objectives deal with the graduates and the alumni respectively. The Programme Educational Objectives represent the fourth layer of the pyramid which should include the overall educational objectives of a programme. The Programme Educational Objectives are aimed at achievements of the Alumnus of the programme. A strong alumni relationship and tracking their achievements will allow better interaction with the institute towards achievement of OBE

The third layer of the pyramid is that of the mission of the programme which is an action based plan that the programme needs to possess in order to achieve the Vision. The top layer of the pyramid consists of the Vision which has to have a implication with a larger time horizon.



Figure 1. Pyramid structure for a good programme plan

B. Role of Programmes during accreditation

Accreditation is a process by which one can easily achieve outcome based education because the accreditation committee follows Washington Accord. This is a treaty signed in Washington to standardize and develop the educational standards.

The co-ordinator for a programme has to make a decision based on their present situation of the engineering education whether they comply with the requirements of the Washington Accord which is followed by accreditation committee. If an institute is planning for accreditation it has to prepare a Self Assessment Report. This report is a reflection of the institute's compliance with the achievements and performance of the programme. This report has to be submitted to the committee and they audit the report and assess the quality of the programme. There are twelve Graduate attributes of NBA N J Rao, 2013 which the NBA has set as guidelines while designing the outcome are as follows:

1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. Problem analysis: Identify, formulate, research literature, and analyze complex engineering problems

reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

The above twelve attributes are expected to be the Programme Outcomes of the graduate. The graduate attributes are measured using direct assessment tools and indirect assessment tools. Direct and indirect assessment tools involve semester/year end examination results, alumni survey, course end survey, employer's survey, faculty

survey etc. The project that the graduate submits at the end of the course has the maximum applications of all the attributes. Thus, if more the student involves in a project during their academic career more will be the attributes that develop in the graduates.

C. Practicing through Cooperative learning

To implement the outcome based education, innovative teaching methodologies have to be explored. One of these is co-operative learning activity[6]. There are ample tools for co-operative learning such as Brainstorming, pair composition, Think Pair Share, Focused Discussion Pairs, Peer Questioning, Instruction etc [4, 5]. A few of these tools were experimented in the classrooms

D. Think Pair Share

This methodology is very essential in subjects where there is a multiple solution to a given question. In an example of Metrology and Measurements for a given parameter to be measured there are various different measuring techniques available. In this example only one question is considered to depict the implementation of the tool.

In a traditional setup the faculty generally dictates a problem which is from the text book exercise and solves it over a presentation or a white/black board. In this process there is more of teaching that happens. However, the learning part is incomplete because of lesser amount of students are engaged in the classroom teaching.

This can be avoided by implementing think pair share method which is as follows:

- **Think Phase:** In this phase the question is asked to the student and the student needs to think about the answer and make notes of the same.
- **Pair:** In this phase the student need to pair up with another student and discuss the answer and come up with a solution which is more refined.
- **Share:** In this phase one of the teammates present the answer, while presenting the answer the student discusses with the faculty the possible multiple solutions.

Role of the faculty is to moderate the session by helping the students with the right answers and guiding the students. Fig. 2 shows the image during the Think Pair Share session in progress. We can observe that initially only two groups are active and the rest were not so active. This is when the faculty needs to moderate and ask a quick question or two to make sure the activity is working.

Think pair share experiment is discussed below considering a class of 60 students in Mechanical Engineering department of BMS College of Engineering. The following were the outcomes of the experiment:

- Lesser engagement was observed in the first phase where they needed to think. However during the pair phase there was complete involvement and during the share phase most of them could understand the concept better due to 100% engagement.

- This tool is highly effectiveness for a size of 60 students.
- This strategy did not consume more time but just 30 minutes for planning and 30 minutes execution.
- The question asked had the application of all the formulae and theory that needed to be used while solving the problem. Thus, the entire topic could be summarized.
- Amount of students who were interested was highly motivating for the faculty.
- A feedback result showed that 88% accepted the new method and mentioned that this method of teaching learning is more fun filled and engaging as compared to chalk and talk method.



Fig. 2. TPS Activity in the class

E. Theme based learning exercise

While teaching subjects that have a case study or which has application of concepts, theme based learning is very ideal to recall and understand the fundamentals of the concepts. In a study of theme based learning exercise one of the authors in the class of 62 students learning basic mechanical engineering conducted the following experiment.

The faculty applied the theme where a class representative is elected by opinion poll and election based themes similar to the real life scenario. Most students that the faculty was addressing were above the age of 18 who were eligible for voting. The outcome in this theme was to bring a social consciousness about the seriousness of voting and emphasizing the need to understand the subject. The following procedure was followed:

1. Faculty announces the intention of choosing the class representative and asks students to volunteer to lead the class as a representative.
2. Faculty explains the roles and responsibilities of the representative. An expected 3-10 students in the class every year get ready for volunteering since 2012-2014 in each semester.
3. The students who express the willingness are grouped into smaller sections and are asked to form parties that simulate an election poll.

4. The faculty now opens the hall for the students who can ask doubts about a topic that will promote a discussion.
5. The students with their team will answer the questions which should satisfy the entire class.
6. Faculty may act as a moderator.
7. Finally the student who answers the maximum queries is elected by the class as the representative.

This example illustrates the theme based learning which yields in empowering students with leadership and technical skills. The class was interactive and each student was eager to be part of the groups. The following are the outcomes of theme based learning process:

- It acts as a bridge between the student and faculty divide
- It can help students become aware of two subjects simultaneously. In this example polling and the technical subject of interest
- It helps understand the necessary qualities of a leader
- Helps in improvement of team work.

F. Group based learning

In another experiment the subject of metrology and measurements was presented by the students. The aim of this experiment was to measure the understanding of the class with respect to the subject that was discussed earlier.



Fig. 3: Groups discussing topic in the class

1. A total of 60 students participated in the experiment.
2. The subject considered was of Mechanical Metrology and Measurements on Limits, Fits and Tolerances.
3. All students were instructed to be prepared for the subjects and were allowed to bring any material that will help them to chart about the topics given

4. The class was divided into smaller groups as in fig.3. Each person of the group were given the subtopics
5. Then the students were allowed to discuss and come out with a explanation of the topic by charting it on a large sheet of paper.
6. This was then shared with the entire class and the topics were discussed in detailed as shown in fig.4.

The time allocated for this activity was 2 hours with 1 hour for preparation and 1 hour for presentation. The activity was well performed by the students. The faculty moderated the session and provided inputs and evaluated the groups. The group that presented the best was allowed to publish their work in the class for a week



Fig. 4: Groups presenting their work

The following are the outcomes of the group based learning activity:

- Students actively participated in the activity and showed their expertise in the topic as shown in fig.5
- There was individual as well as team work in the activity
- The learning objective was well achieved which showed in their performance in the exams. Most of the students scored better grade as compared to previously.
- Created a environment which became more friendly and learning oriented
- Activity increased time consciousness in students.
- Faculty had a great time interacting with the students which reduced the gap between students and faculty.
- Communication skills of the students were displayed and improved confidence among students.



Fig 5: Exhibit of the group work by students

III. CHALLENGES

A. Bringing change in the system

The traditional teaching learning system involves teaching objectives more and lesser emphasis is given on the learning objective. The new model of Outcome Based education system emphasizes on learning objectives. Some of the challenges faced in this regard are as follows:

1. OBE involves preparation time and in the present scenario, the teaching faculty might show some resistance to this concept. However, after implementation the process becomes more fun and enriching.
2. Meticulous planning is required from the management, staff and the programme coordinators to make this process effective.
3. Bringing up the infrastructure and environment to facilitate OBE requires economic support in some Indian universities which are cash strapped.
4. Change of attitude in the minds of faculty similar to the change that was brought by computers replacing its predecessor typewriters.

IV. CONCLUSION

Some of the tools discussed here are the basic tools that can be used in making OBE an effective strategy in the teaching learning process. The tools that are discussed here are those which were tried in the department of mechanical engineering in the past two years. With the use of the tools the following conclusions can be drawn from the experiments that were conducted:

- Any institute which aims at accreditation in the near future has to comply with outcome based education which is a mandate by most of the regulating authorities of India.
- Following outcome based education is an opportunity to make Indian graduates globally competent.
- New and Innovative tools if followed in the class will result in better understanding and a great learning environment for students and faculty.

- By using different tools faculties are empowered with more knowledge as compared to traditional methods.

- Students are exposed to team work and individual thinking

In the context of the teaching fraternity, innovative teaching is the way to go in the upcoming years. There is a huge scope for future work and implementing Outcome Based Education in the programme, thus ensuring employability and achievement of learning objectives. Table 1 shows the attainment of the various tools for achieving OBE.

Table1. Rubrics showing the achievement of various tools

| Tools | Learning Outcomes | | |
|----------------------|-------------------|--------|-----|
| | High | Medium | Low |
| Think phase | | | ✓ |
| Pair phase | | ✓ | |
| Share phase | ✓ | | |
| Theme based learning | ✓ | | |
| Group based learning | | ✓ | |

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