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'Cooperative Learning' Tool for Optimizing Outcomes of Engineering Education

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Abstract: Quality of technical education is a very sensitive issue because the parameters of assessment of quality vary from time to time. In simple words, high quality education is one that fulfils the needs of all stake holders. Formal education system tends to restrict the minds of faculty as well as students to trodden path that doesn't encourage change and innovation.

Objective of higher education is not just imparting technical knowledge but also to inculcate a diverse set of skills such as problem analysis ability, ability to develop solutions, ability to use modern tools, concern about society and environment, ethics, communication skill, ability towards teamwork and ability of life long learning. To comply with the demands on outcome, educators are challenged to embrace new models of teaching with more emphasis on students' learning that reflects in the desired outcomes.

In line with this characteristics of outcome based education, this paper discusses facts about current scenario of instructional methods along with the potential of 'cooperative learning' tool to improve the teaching learning process in engineering education.

Keywords: Instruction method, cooperative learning, outcome based education (OBE), National Board of Accreditation (NBA)

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1. INTRODUCTION

Quality assurance and quality assessment are the key factors for improving quality in engineering institutes.

A harmonious relationship between technical education, national and social needs and global trends is desirable. In the global context, there is a need to produce technocrats with sound technical knowledge and with an ability to adapt ever increasing demands of their employees in particular and the society in general. Product of technical education is the outgoing student from an engineering institute. Quality product is a student ready to accept challenges of advancing technology and shoulder the responsibility of social transformation with proper use of his training and skills with spiritual and human values and professional ethics. However, in recent years, in India the number of private engineering institutions is fast increasing and their quality has become a major concern.

ABET (Accreditation board for Engineering and Technology) on the international horizon and NBA (National Board for accreditation) on the Indian horizon are well recognized organizations that asses quality of engineering education. These organizations have prescribed guidelines covering different factors to evaluate quality of education in the institutions. NBA quotes certain criteria to evaluate the quality of education. Some of them are- teaching learning process, innovations in activities of faculty in teaching-learning process, developmental activities in academics (Manual of accreditation, 2015). Incorporation of new technologies in the instructional methods and finding new ways to asses learning experiences is necessary to attain a diverse set of course outcomes and program outcomes.

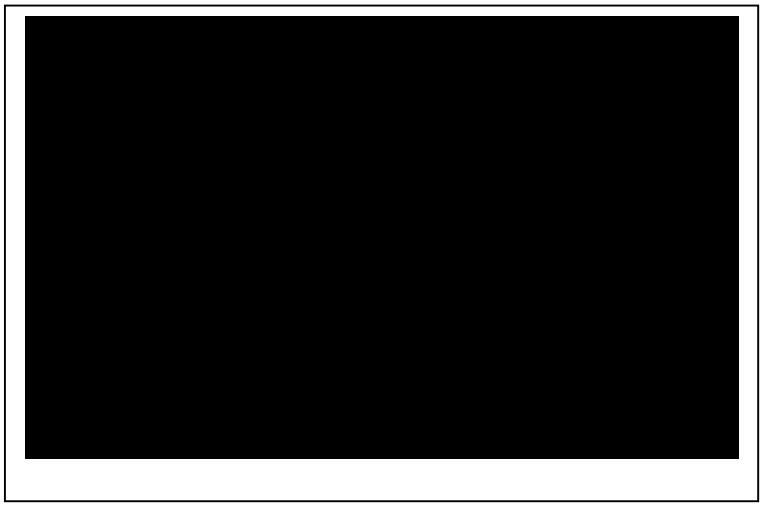

Fig 1 Information retrieval for classroom teaching methods

2. TEACHING LEARNING PROCESS

Teaching-learning process is one of the most significant factors that determines the quality of technical education system. ABET and NBA promote outcome based education (OBE). In the context of OBE, learning objectives and outcomes of the program and each course in the program need to be well defined and properly measured. The same is true about each unit in a course, Without improving the existing system of education, one cannot cope up with the present and future needs of OBE. NBA expects innovations by the faculty in teaching leaning process for effective and efficient instruction methods -specifically mentioning use of pedagogical initiatives such as collaborative learning. NBA also expects to encourage bright students and assist weaker students(Manual of accreditation, 2015).

A. Spectrum of classroom teaching

Effectiveness of teaching learning process is measured by information retrieval by the students and its consequent application. Effectiveness depends on the classroom instructional method. Learning of a student during classroom sessions can be broadly classified as passive and active learning.

As on today, the instructional method adapts mainly lecturing method which is a passive mode.

B. Passive learning

This is a teacher centric method. Students are passive - watching, listening and (may be) taking notes, but seldom actively thinking about the material being presented. Cognitive science tells that information received passively is not retained in long term memory. However effectiveness of a lecture can be improved by using audio visual aids as indicated in figure 1. One more challenge in this method is to hook the student's attention for a span longer than the natural span of 20 minutes (Kumar, K.V., 1998).

C. Active learning

In this method, student participates actively in the learning process. Laboratory session is a common example of active learning. However, active learning can be incorporated in a lecture by including small activities like energiser, question answers, problem solving. There are two sub categories of active learning-

- Individual active learning
- Collaborative active learning

In individual active learning, students individually participate through seminar while in collaborative learning method, students work in group.

An engineer will have to work in multidisciplinary teams in his professional career and his performance evaluation may depend more on his ability to work in team than his technical skill. Hence it is one of the program outcome mentioned by NBA.

Information retrieval percentage is high in active learning and it goes on increasing as one travels towards the base of triangle in the fig.1. Collaborative learning is more effective than individual active learning.

But, it is a real challenge to promote an active learning method in engineering education within the existing constraints like time limit for syllabus completion in a semester pattern, discouraging attitude of faculty, students and parents.

D. Efficient Teaching and Effective Teaching

Pre NBA, a teacher's efficiency was measured on the basis of his/her students' score in the examination. However, it was sufficient for a teacher to prepare well and teach well. With the arrival of concept of OBE, this paradigm is likely to change. As outcome of education is determined by the quality of student in terms of his technical expertise, confidence, and ability to work independently and in a team; a time has arrived to watch not just how a teacher teaches but also how he makes students to learn.

3. OBJECTIVES OF THIS PAPER

To study different instructional methods and aids used by faculty in engineering institutions and to weigh the potential of cooperative learning as effective instructional method to attain desirable outcomes in engineering education.

4. RESEARCH METHODOLOGY

This research employs a statistical survey methodology. It consists of two phases-

- Data collection
- Data analysis.

A. Data collection

To collect the data about instructional and assessment methods and their effectiveness, a questionnaire for faculty was designed. A questionnaire for students was designed to collect their feedback on effectiveness of cooperative learning method. The answer samples were collected from-

- Faculty of different engineering institutes.
- Participants of STTP on 'Total Quality Management in Engineering Education' organised at KIT's college of Engineering, Kolhapur.
- First Year Engineering student participants in cooperative learning sessions.

Total number of samples collected from faculty members of different engineering institutions is 100. Random sampling method is used for collection of data. Hence, data is obtained from a heterogeneous group in terms of age and teaching experience, teaching at various levels i.e. from first year engineering to final year engineering. Total number of samples collected from FE students of KIT's College of Engineering is 120.

B. Data Analysis of faculty survey

Statistical analysis of the samples is presented below.

1) Mission of teaching: 50% faculty perceived only one mission- that of imparting knowledge to the students, with emphasis on genuinity and depth of knowledge. Other members contributed by stating multiple missions viz.

- To create leaders
- To create technocrats
- To develop personality
- To motivate
- To improve communication

26% faculty stated that a teacher's role is important for overall personality development of student emphasizing a fact that these students are the future pillars of 'technically sound' and 'socially responsible' section of society.

In context of OBE, it is necessary to enlighten the faculty on the mission of teaching.

2) Teaching aids and instructional methods: According to literature survey, commonly used teaching aids are blackboard, OHP and multimedia projectors, models. Audio visual aids help to hook the attention of students and results into more retention. Use of audio visuals is also useful to bridge the gap between thinking rate of a listener and speaking rate of a presenter (Kumar, K.V., 1998).

Response to this question is displayed in figure 2. It shows that 38% faculty use only blackboard in lecturing method (passive learning). This indicates their reluctance to adapt new instructional methods. Not just attitude, but lack of facilities is also the reason behind this rigidity. 44% faculty use OHP, multimedia projector and 18% use models along with blackboard.

Other techniques like seminar, group discussion, cooperative learning are hardly used; though majority of the faculty agreed on effectiveness of these methods.

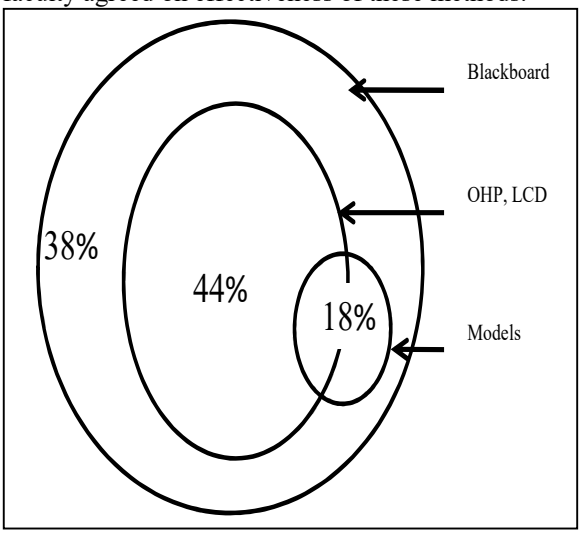

Fig 2 Use of teaching aids

3) Efforts to make the classroom sessions interactive: There is a general tendency of students to remain passive in the class. The faculty participating in the survey expressed that, unfortunately students admitted to the engineering course are exam oriented and hence there is a necessity to counsel the students to change this attitude.

Our survey showed that 58% of the faculty expressed that use of innovative instructional methods and making the classroom session more interactive will improve the effectiveness of teaching learning process (Fig.3). 16% faculty expressed the need of counselling and mentoring of students about benefits of individual active involvement in the class. Only 16% faculty members use energisers like puzzle, problem solving, role play, short and relevant story in the classroom. However it is a matter of concern that remaining 42 % did not express any opinion.

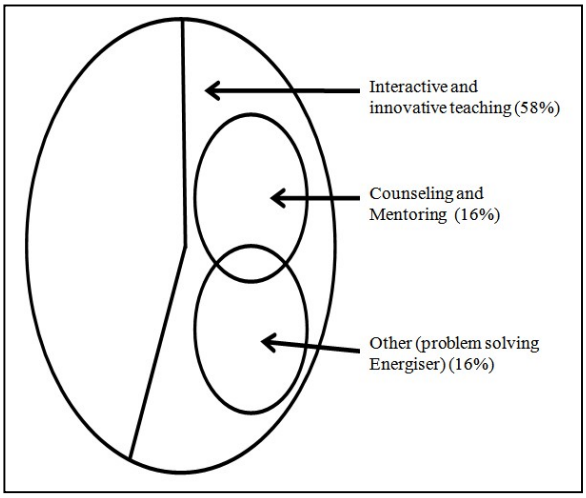

Fig.3 Methods to improve classroom teaching

4)Awareness about cooperative learning: Hardly a few faculty were aware of the term 'cooperative learning'. Most of these were novice faculty. 86% faculty expressed willingness to undertake a training for cooperative learning. Those who knew the concept of cooperative learning, did not practice it.

C. Cooperative learning

Cooperative learning is an improvised form of collaborative learning. Difficulties incurred in collaborative learning are due to interpersonal conflicts among the students that arise because of different senses of responsibility, academic goals and personalities. These difficulties are overcome in cooperative learning as it is designed on The principle of each member group assisting the fellow members and thus ensure that everybody learns.

The faculty should enlighten the students about following elements of cooperative learning and also monitor them during a cooperative learning session.

- Positive interdependence: Each group member has a unique contribution to make to the joint effort because of his or her resources and/or role and task responsibilities. Students have to rely on one another for the effort to be successful.
- Group heterogeneity: The faculty should form a heterogeneous group, so that each member is exposed to diverse abilities of group mates.
- Promoting interaction: If the team simply distributes the work and combines the individual parts together without discussion, it is not cooperative learning. Instead, the members are expected to discuss / debate to come to a common consensus.
- Individual accountability: Each team member is held accountable for everything in the team. If a student does not contribute and understand the concept, then he does not get a credit. The group should be small enough to ensure a scope for participation of all students
- Use of interpersonal skills: Skills like time management, communication, leadership, conflict resolution skills are needed to work effectively in a team. The faculty should guide the students to develop these skills.

To learn a pre assigned topic, different learning activities can be used. Some techniques of cooperative learning are-

- Think-pair-share
- Jigsaw (I and II)
- Three step interviews
- Round robin brainstorming
- three minute review

In lecturing method, most of the students do not undergo any prior study by own will. Also, after the lecture, for reinforcing the knowledge, they tend to use limited resources viz. resource faculty, textbook and seldom reference books. But, in cooperative learning, the topic of study is preassigned to the students. They experience a healthy peer pressure to perform better in small group. Hence they tend to use a variety of additional resources viz, internet, journals for preparations.

In OBE, some of the NBA-listed outcomes are-

- Ability to work in multidisciplinary teams
- Communication skill.
- Ethics to build a coherent society

The necessary attitude and human values to attain these abilities are inculcated through the cooperative learning.

In cooperative learning, students learn more, learn upto deeper level, are less likely to drop out and develop more positive attitudes towards the course subject and greater self-confidence (Felder and Brent, 2004, Felder and Brent, 2007).

Cooperative learning contributes more towards fulfilling objectives of education because of the very element of active participation of the student. Cooperative learning groups have students with wide variety of abilities, attitudes, interests, level of motivation. Weak students working individually are likely to give up when they get stuck; but, working cooperatively, they keep going. Strong students faced with the task of explaining and clarifying material to weaker students often find gaps in their own understanding and fill them in. Thus, students from all categories are benefitted creating a 'win-win' situation.

Role of teacher in cooperative learning:

- Explain Lesson Objective
- Decide Group Size
- Fix Seating Arrangement (face-to-face)
- Assign the roles
- Make available materials
- Teach social skills
- Evaluate performance of the groups and group members

1) ***Data Analysis of students' survey:*** During last 3 academic years, the authors of this paper have conducted a series of 'cooperative learning' sessions using 'Think–pair-share' and 'Jigsaw II' techniques (https://en.wikipedia.org/wiki/Cooperative_learning, Schul, 2012) for the courses of Engineering Physics and Basic Electrical Engineering. In 'Think–pair-share' method, The topics assigned were of analytical nature and informative nature.

In 'Think-pair-share' technique, a small topic was given to the students that will typically need 10 to 15 minutes for discussion. The students discussed the topic in pairs and came to a common solution or conclusion. For informative topic, the pair presented the conclusion orally. For analytical topic, the pairs wrote down the solution. The answers were assessed by the faculty.

In the original 'Jigsaw' technique, students are divided into groups called as home groups. In home group, each student is assigned a different topic. Once a topic has been identified, students leave the home group and group with the other students with same topic from other groups This new group is called as expert group. In the expert group, students learn the material together and then return to their home group. There each student teaches his or her assigned topic to other members of home group. However, we have followed 'Jigsaw II' technique to compromise with the time constraint. 'Jigsaw II' is a Robert Slavin's variation of original 'Jigsaw' technique.

Cooperative learning was implemented for specialized goals like knowledge consolidation. For this we taught a topic briefly and then used the JigsawII technique for in-depth study by the student groups. In this method, each group consisted of 6-8 students. They learned together a pre-assigned topic. Each member focused on separate bit of the topic and became an expert and taught the other members of the group. After this, the groups made final presentations. They exercised creative ideas for presentations viz. posters, role play, quiz play etc.

Another area that we explored using cooperative learning is the solution of numerical examples to achieve higher cognitive level in Bloom's taxonomy where application of knowledge is required.

After each session, students' feedback on cooperative learning was collected. Statistical analysis of the collected feedback was done. 86.66% students voted for the cooperative learning method. 80% students expressed the willingness towards using the cooperative learning method once in a week in the beginning and expressed that the frequency can be increased later. 20% students exhibited a desire for a higher frequency. Basic advantages of this method against the lecturing method pointed out in the students' feedback are-

- Better understanding: 100% students agreed that they understood the topic better. This was reflected in their presentations.
- Development of interpersonal skill: 88% students experienced this.
- Development of Communication skill and presentation skill: 100% students agreed on the benefit.

5. CONCLUSION

Results of this survey indicate that in the context of OBE, a paradigm shift in methods of instruction is necessary. It is a teacher's responsibility to get acquainted with the new technological knowledge and practices to deliver and motivate the students.

It is observed that, in cooperative learning method, teacher-student interaction and students' contribution in learning process is more. Cooperative learning method is more effective because it is learner centric.

Cooperative learning activity helps to inculcate the skill to resolve interpersonal conflicts, communication and other social ethics, time management and creativity. Thus, cooperative learning method not only helps to achieve course outcomes (COs) and program outcomes (POs) in cognitive

domain but also in affective domain. There is a scope for every faculty to explore new techniques to cater for requirements of his/her course and class.

Looking at the effectiveness of this method in the context of OBE, we recommend the promotion of this method in engineering education. The factors of hindrance and the respective solution are-

- Reluctance of faculty to use innovative methods is due to fear of failure, lack of facilities.
- The faculty should know how to form teams and equip himself to deal with the problems that commonly arise in team. Hence there is a need of training the faculty about this method.
- A positive response from students also decides the success of this method. Hence prior orientation of the students by stating unit learning objectives (ULOs) and unit outcomes (UOs) is required.
- In semester pattern of education, time limitation is a major concern.

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