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Practice vis-à-vis Benefits: An Assessment of the Teaching-Learning Methods Employed in Engineering Education

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Abstract:The study had two key objectives. First was to explore the teaching and learning methods currently being practiced by engineering college faculty members, and, second was to review the perceptions of the engineering teachers on the teaching-learning methods that would benefit the engineering students. To achieve the objectives, a study was conducted among faculty members handling classes of engineering students of various engineering colleges affiliated to a technical university of Odisha. The sample size comprised of 109 faculty members from 23 different engineering colleges affiliated to the technical university. The responses of the participants were elicited through a questionnaire-based survey and the eight most popular teaching and learning methods were used as questionnaire items. The study outcomes communicate that the participating faculty members are not much aware of how problem-based and project-based teaching and learning approaches can benefit their students in the classrooms. Furthermore, the results also revealed that group discussion, project-based method, problem-based method, case-study method, brainstorming and role playing are not very popular teaching-learning methods among faculty members. The respondents all agreed that they do not practice these methods too frequently in their classes. The chalk and talk method is the most common teaching-learning method that is widely used by the participants, followed by the audio-visual method. According to the participants these two methods of teaching and learning are most useful for engineering students.

.**Keywords:** Teaching, learning, pedagogy, instructional methods, engineering education, teachers

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1. Prelude

Education enlightens us, begets knowledge, and infuses skills and values within us to take informed decisions befitting a human being. The knowledge it instilsthus strives at making each individual an intellectual citizen of the nation. Education not only makes a human being a literate person, butalso makes him responsible for the promotion of human capital and technological innovation, thus contributing to the economic growth, social elevation and cultural development of a civilization.

In the year 2008, National Academy of Engineering (NAE), United States, had released a report on the "Grand Challenges for Engineering" in the 21st century. The report stated that fourteen grand challenges are open and waiting to be addressed by engineers for generating engineering solutions,

towards improving life on this planet. The fourteen challenges were identified by an international group of leading technological thinkers, and these challenges traverse four cross-cutting themes such as, "Sustainability, Security, Health and Joy of living."Thus, the role of engineering education, with the active involvement of engineering educators, and cooperation and participation from industry personnel, is highly imperative in preparing the future generation engineers to address these grand challenges.

Researchers and academicians around the globe have suggested and recommended that engineering education needs to make changes in three arenas.

First - to accommodate the curriculum with more interdisciplinary courses and internships; second -to encourage the students' involvement in extracurricular activities, and third -to adopt and practice new methods of teaching and learning mechanisms that can enhance the students' learning experiences(Lemaitre, Prat, GraaffandBot, 2006; Vyas andChauhan, 2013; Nair, Patil and Mertova, 2009; Shuman, Besterfield-Sacre and McGourty, 2005; Passow, 2012; Martin,Maytham, Case and Fraser, 2005).

This paper primarily focuses on the third change recommended by the experts. It examinesthe teaching and learning methods practiced by the engineering faculty, and also highlights the perceptions of the engineering educators on the other potential teaching and learning approaches that can benefit the students.

2. The Present Study

A study was conducted among faculty members handling classes of engineering students of various engineering colleges affiliated to a technical university ofOdisha. The study was carried out during the year 2016 for a period of eight months from February to September. The responses of the teachers were elicited through a questionnaire-based survey by visiting their colleges. The participation of the teachers was completely voluntary. Data was collected from the teachers while they were in their own faculty rooms. To encourage more participants to participate in the study, a web-based survey was also opened during the stipulated period from April to September. The questionnaire for the web-survey was formatted using Google forms and the form link was sent to the faculty members via e-mails. The response rate of participants who participated in the web-based survey was eighteen percent (18%).

The sample size comprised of 109faculty members from 23different engineering colleges affiliated to the technical university. The study sample included both the self-financing and government engineering college participants. In this study, 79% participants were from self-financing engineering colleges and 21% were from government engineering colleges. The participants were from six different departments, such as, Computer Science and Engineering, Civil Engineering, Electrical Engineering, Electronics and Communication Engineering, Mechanical Engineering, Humanities and Basic Sciences that included faculty members from English, Mathematics, Physics, Chemistry and Management studies.

The study comprised of 71% male participants and 29% female participants, at various positions and levels - Professors (14%), Associate professors (32%) and Assistant professors (54%).The highest qualifications of the participants comprised the following: Ph.D. - 15.5%, Master of Technology - 72.4%, M.Sc., M.Phil. - 8.2%, M.A., M.Phil. - 1.8% and MBA - 1.8%. Ten percent (10%) of participants have more than 20 years of teaching experiences, 16.5% participants have teaching experience of more than 15 years, and 43.1% have more than ten to fifteen years of experience. Twenty two percent (22%) participants have teaching experience between five years to less than ten years, and 8.2% have teaching experience of less than five years. Ten percent (10%) participants have working experiences in industries prior to teaching.

3. Significance of the Study

Definitely teachers use various innovative teaching methods in their classrooms to make the teaching learning process interesting and relevant for their students, yet the question that is always raised is - "Are the teachers teaching well enough?" This study explores the teaching and learning methods widely used by the engineering faculty of the chosen parent university. The study outcomes are expected to assist the participants to measure their own views and also other participants' views on the teaching and learning methods currently being practiced, and the learning methods that have the potential to be adopted in future for better classroom teaching. The study findings will help the various colleges and the university to provide

necessary facilities to the faculty members so that various levels of instruction methods could be practiced in the classroom.

4. Study Limitations

- The participants'handle classes for engineering students. Therefore, the outcomes of the study cannot be generalised to non-engineering students.
- Since all the participating colleges are affiliated to a single technical university, the results of this study cannot be generalised to other such universities, where the teaching and research environments could be entirely different from the current university.

5. Research Objectives

- To explore the teaching and learning methods currently being practiced by engineering college faculty members.
- To review the perceptions of engineering teachers on teaching and learning methods that would benefit the engineering students.

6. Research Questions

- What are the teaching and learning methods that are currently being practicedby engineering faculty members?
- What are the potential teaching and learning methods that would benefit engineering students?

7. Framework of the Instrument and its Reliability and Validity

Questionnaire was used as a survey instrument to collect data from the participants. The questionnaire was designed after a thorough literature review of engineering teaching and learning methods, and expert opinions. The eight most popular teaching and learning methods were used as questionnaire items, and participants were asked about the teaching and learning methods they practiced in the classrooms and their own perception on the eight listed methods that would benefit the students. A five-point Likert scale was used for recording the participants' inputs. The scale used values ranging from, None, Little, Some, Much, Very much. The instrument was validated by the academic members of the authors' institute and the teaching and learning methods used in the study were marked as popular methods as per the research studies as well among the teaching fraternity.

The instrument's reliability was measured by the coefficient alpha (Cronbach's Alpha).Cronbach's alpha estimates the internal consistency reliability of an instrument by determining how all items in the instrument relate to all other items and to the total instrument (Gay, Mills, and Airasian, 2006, pp. 141-142).If the value of internal consistency is greater than 0.8 then, it is considered as reliable and good (Pallant, 2013). The coefficient alpha for the questionnaire of teaching and learning methods was 0.83 and this higher value confirmed the reliability of the instrument. The study used Statistical package for Social Sciences (SPSS) 22to analyse the data. The data was analysed using descriptive statistics.

8. Findings

9. Analysis

Table 1 shows that chalk and talk method is the

Table 1. Teaching and learning methods practices and perceptions about its benefits

	Mean Values	
Items	Practice	Benefit
Audio-Visual aids	4.3	4.5
Chalk and Talk method	4.8	4.5
Problem-based learning	3.4	4.2
Project-based learning	3.5	4.1
Brainstorming	3.7	4.1
Group Discussion	3.0	4.1
Case study	3.4	3.9
Role play	2.7	3.4

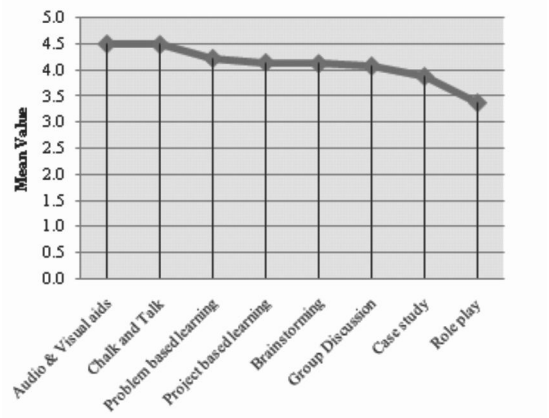

Figure 1 Perceptions of Teachers on Teaching and Learning Approaches that Benefit

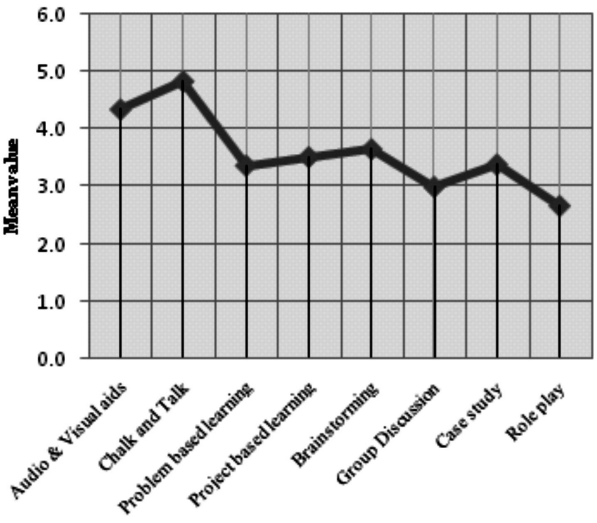

Figure 2 Teaching and Learning Approaches Practiced by the Teachers

most common teaching-learning method that is widely used by the participants. This traditional method scored the highest mean rate of 4.8. Audio-visual aids such as using presentation tools are the second highest teaching and learning method that is practiced and it scores the mean value of 4.3.

The mean rates scored by the chalk and talk and audio-visualaidsclearlyindicate that these two are the most popular and common methods practiced by the faculty members accessed for this study. Moreover, these approaches are the only ones that scored mean values greater than 4.

From, Figure 1 and 2, we understand that the participants believe that these two methods of teaching and learning would benefit the engineering students, and both these methods shared the same mean value of 4.5 each. The gap existing between the practice and benefits of these two methods are 0.3 and -0.2 respectively. The negative gap -0.2 informs that the faculty members are well aware of the benefits of audio and visual aids method but, they do not regularly practice this particular method.

Table 1 show that project-based learning method and brainstorming and group discussion method share the same mean value(4). This result conveys that the participants hold a view that these methods will bring similar benefits in classroom teaching. On the contrary, project-based teaching and learning method scored the fourth highest mean rate, of 3.5 and brainstorming scored 3.7 (Figure 2),occupying the third highest mean value as the method practiced by the participants.

The mean value difference between project-based method practiced, and benefits, is -0.6 and brainstorming is -0.4. The numeric negative gaps reveal that though the participants understand the benefits of these methods, they fail to execute these in the classrooms. Group discussion is the second lowest method that is practiced by the participants and it scored a mean value of 3.0. Among all the given methods, group discussion only holds the highest mean gap (-1.1) between practice and benefits.The mean value of problem-based approach practiced is 3.4, and benefits, is 4.2. The mean difference between practice and benefit is -0.8. This is the method that scored the highest negative gap.

Studies by Mills and Treagust (2003), Theonas, Hobbs and Rigas (2008), Moalosi, Oladiran and Uziak(2012), Lehmann, Christensen, Du, and Thrane(2008) and Acar (2004) have highlighted the benefits of project-based and problem-based learning methods, and also discussed the benefits of practicing problem-based and project-based learning in engineering education. These studies tell that both the methods include real world problems that require teamwork and teacher guidance.

Problem-based learning gives more emphasis on knowledge acquisition (Perrenet, Bouhuijs, and Smits, 2000), while project-based learning focuses on the final results and gives emphasis on application of the knowledge acquired(Frank,LavyandElata ,2003). As suggested by Hmelo-Silver and Barrows (2003), in problem-based method the teacher or facilitator "scaffolds student learning through modelling and coaching, primarily through the use of questioning strategies."

According to Gijbels, Dochy, Van den Bossche and Segers (2005), project-based learning is a discovery-based learning method "intended to guide students to become experts in a field of study, capable of identifying the problems of the discipline and analysing and contributing to the solutions." Even though the benefits of these two methods are reported by several studies, the practice is still far from being generally practiced in classrooms. This study results also confirm the same.

Case-study is the fifth highest method (3.4) practiced by the study participants, and the

participants believe that practicing this method in the classroom will not yield much good results. Further, this is the second lowest method with the mean value score of 3.9 in the benefit section.

Role play is an instructional method that has been a part of the repertoire of teaching and learning process since long. This method helps the students in developing teamwork and communication skills. Role-play is a case-based method which helps in development of personal and interpersonal skills (Maier, Solem and Maier, 1975;Craig and Amernic, 1994) and is primarily used to teach ethics in engineering (Cooley, Klinkhachorn, McConnell and Middleton, 1991; Herkert, 1997; Didier, 2000; Brummel,Gunsalus,Anderson and Loui, 2010).

Studies conducted by BybeeandSund (1982) and Zowghi and Paryani (2003) inform that role play helps the students to understand difficult engineering and technological concepts easily.It promotes interactive learning and inter-group learning. “The general purpose of role-playing in teaching is to gain enhanced learning outcomes for the participants,” suggest(Andersson and Andersson , 2010).

As per the study outcomes, role play scored the least mean values both in practice and benefits. Table 1 illustrates that the values scored by this method are 2.7 and 3.4 for practices and benefits. The mean gap existing between practices and benefits for case-study and role play are -0.5 and -0.7. It is regrettable to know from the study findings that the faculty members who participated in this study are neither practicing very well, nor are they much aware about the benefits of practicing case-study method orthe role playing method.

Overall, the results inform that the participating faculty members are not much aware that the students how the students will be better benefitted if at all problem-based and project-based teaching and learning approaches are more frequently practiced in the classrooms. These approaches are highly student-centered learning approaches that facilitate learning among students.Furthermore, the authors observe that chalk and talk is the most popular teaching and learning approach being practiced by faculty members of the affiliated colleges of the study university.

Figure 2 establishes that group discussion, project-based method, problem-based method, case-study method, and role play are not very popular teaching and learning approaches among faculty members, because the participants agreed that they do not practice these methods. Figure 1 reflects the participants' perception that chalk and talk and audio-visual aids are the two methods that will benefit classroom teaching.

The study findings clearly communicate that the dominant teaching and learning methods used in engineering education still remains chalk and talk, in spite of its ineffectiveness that has been identified by a large body of education research and academicians(Bernold, Spurlin and Anson(2007),D'Inverno, Davis and White(2003), Young, Robinson and Alberts(2009), Acar (2004), Vest(2008), Smith and Waller(1997), Savoy, Proctor and Salvendy(2009), McAuliffe, Hargreaves, Winter and Chadwick (2009),Bhattacharya (2008)).

10.Recommendations and Conclusion

The outcomes from Figure 2 show somewhat positive signal that the participants are practicing problem-based, project-based, brainstorming and case-study methods. But, Figure 1 shows negative signal that the participants are not muchaware of the benefits of problem-based, project-based, brainstorming and group discussion learning methods.

The authors suggest that institutions must use the funds allocated by the university and government for conducting teachers' training workshops and short-term courses on effective teaching and learning methods, so that engineering faculty would be able to make use of the methods effectively.

Faculty members must be encouraged to participate in the workshops, short-term coursesconducted by other superior institutions. Further, faculty members must compulsorily participate in conferences and seminars relating to engineering education. Even, the faculty members can be sent to other institutions for observation-visits so that they get opportunities to understand the methods followed by faculty members in superior institutions.

It is high time the young engineering minds of our nation are motivated to studyengineering for gaining knowledge, and not simply to get a degree for job purposes. The nation can then be in safe hands and march towards innovation and progress at a faster rate.

It is the responsibility of the engineering institutions to educate the potential engineers to work across different disciplines.

To educate our future-generation engineers, engineering faculty should make use of efficient and effective teaching and learning methods.And this can happen only when the faculty members know the proper teaching methods themselves and practice them appropriately in classrooms.

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