Best In-Class Interactive Teaching and Learning Approaches in Engineering and Technology Education

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ABSTRACT

Nowadays everyone has access to the information and this is the age when role of a teacher is to teach the students about the use of the available information to help their surroundings. Purpose of this article is to highlight those in-class teaching practices which could make the 80-90 minutes duration of teaching and learning more productive for the engineering students, and keep them lively and concerned in learning activities. We discussed some practices related to interactive teaching and learning in the class, so that traditional "Lectio" system can be converted into interactive learning environment. Approaches discussed in this article are heuristics of authors and renowned academicians at reputed institutes of the world; and have been fruitful in teaching and learning in different domains of engineering and technology. To produce quality engineers and technical experts, academia needs the social and interactive educational environment. Its purpose is to retain the knowledge in students' mind and make them proficient to apply it, to solve the real world problems. In this article remedies for the dilemma of gap between academia and industry (outcomes of traditional teaching and learning approaches in engineering and technology) have been discussed.

KEYWORDS

Interactive teaching, teaching in engineering, active learning approaches.

INTRODUCTION

Teaching is nothing but to help the students learn more and interactive teaching is to make them learn, "how to learn". Best teachers keep the train tracked by using their own experiences, about student's conception, and human learning (Ken, 2012). Teaching is not the way to transfer information to students but to train them to apply their knowledge to solve the real world issues. We are living in 21st century, in this era industry demands from academia to produce the people who can tackle the situations they have never been encountered before. In this era, if we produce students with a lot of information but without any learning to apply their information to serve the real world, such students will not be more than modern Aristotle. "*What professors do in their class matters far less than what they ask their students to do*" (Halpern and Hakel, 2003). It's a natural phenomenon that human attention starts fading after about 20 minutes, that's why while keeping the students attentive in 80 to 90 minutes lecture, a teacher has to come with a new and interesting activity after every 20 minutes.

In this article some key features have been discussed to make learning interactive and productive.

Establish learning objectives

Establish some objectives about your lecture (Silverthron, 2006) and discuss them in the form of short memorable questions in front of the class. This will help the students to know what they really are going to learn about. And at the end of the lecture, it will help you to know how much they have picked from delivered contents, by asking the same questions again. This exercise will also flash back entire lecture in their minds and will help some students to re-pick if they missed something.

Focus more on Practical issues

During lecture focus on practical and real world phenomena, conduct brain storming sessions, and with the help of class participation try to reach to an optimal solution for the problem under discussion. Help students to practice more and more exercises in the class, this will improve their mental understanding. These should be your own made exercises, so that students should pay complete attention towards these rather trying to copy from a website. Do not spent time in discussing facts and figures because students can read them from books (Silverthron, 2006).

Student's prior knowledge

Do not start all the technical details about the topic, you are going to teach, at once rather first you describe the real world issues, which could be tackled by the

technology you are going to teach them, then have a brain storming session of a short duration to awake their minds and ask them for the solutions they propose.

Highlight hang-up points for the beginners

In every lesson there are some hang up points for the students but most of the time teachers ignore this. Keep all those points in the mind while preparing the lecture and delivering. Just stop at those points and give them some time to discuss with each other what they think at this point. Meanwhile have a round in the class and listen to their discussions and at the end correct all those misconceptions, what they were discussing about. You can also turn to one-to-one discussion for clearer elaboration of difficult points or you can ask the questions about difficult points. At these points surpass the bookish knowledge and share with them your own heuristics.

Context specific learning

During lecture try to create a real world scenario, make students feel as they are part of that scene with a real issue and need to fix the issue with the technology under discussion. After this, for their practice, give them a bit complicated exercise and ask them to solve it in a group (Woods, 1995).

Divide the class into small Study groups

Divide the class into small groups. Make the groups having participants from different categories of the students according to their grades or level of learning, and gender. Once you feel that you have finished your lecture, assign them a group activity- any real world problem where they can implement their recent learning.

Turn passive learners to active

Svinicky (1999) found that there are some students in the class who just focus on taking the notes of lecture and they do not take part in question answer sessions and discussions, make such students realize that discussion and practical work is more productive than taking notes. Pay special attention to passive students and assign them responsibilities of conducting discussions, as well as preparing and demonstrating some simple projects in the class.

Shorter and frequent feedback

Usually students are asked about the teaching feedback at the end of the course completion and quizzes, assignments and midterms are considered as learning feedback of the student. But according to us, this should be a frequent exercise at the end of each lesson. It can be in the form of cards or credit free quizzes, which

should be anonymous preferably. You can also use feedback card templates designed by experts (Angelo and Cross, 1993). Having questions about the lecture so that it could be guessed what have they learnt? Sometimes they could be asked to present what they learnt, as they are discussing their views to a high school student. Whatever is the mechanism of learning feedback, just note down the points the student hung-up at and discuss them at the start of your next lecture. For teaching feed back after every two weeks ask them to write few lines how their lesson could be made more interesting and productive, in this way they will write about the problem they are facing and then about its solution. Next time while preparing the lecture, consider every positive point. There would be some negative points in their feedback but there is no need to discuss about them, ignore this and keep in mind that there are some students in the class who need more attention or they have more difficulty in understanding the lecture.

Popup quizzes and assignments of minor weight-age

Make it a habit to give your students surprised quizzes and assignments, these should be of very low credential because purpose of such activities is not to evaluate the students rather to keep them active, and to evaluate yourself that how effective you are to keep them learning. But on the other hand such activities must have some credits so that students take them seriously.

Use of technology

Use the latest technologies available. Record and distribute your video lectures before the class and ask students to come up with the questions from those videos, in this way during class, you will be able to spare more time in practical activities. Show them video clips related to topic and ask questions about it. Learning softwares are also available related to every technology; help them to use these softwares to learn more and more.

Oral reports- an interactive way of assessment

Do not rely on traditional ways of assessment. Assessment can be made interactive by oral reports, class presentations, at the spot short project development and demonstration. These interactive activities can be held individually or for the students in group. Main advantage of such assessment is that students may know at run time about their difficulties which cause their negative credential. At the same time teacher has the opportunity to correct the students after evaluation.

Develop meta-cognitive skills in the students

It is also the responsibility of the teacher to nourish the minds of the students. So have some activities to develop their thinking about analyzing the problems,

finding optimal solutions for the problems, and writing critical reports about the problems and their solutions (Bransford, Brown, and Cocking, 1999).

Diversity in the class

Try to lead weaker learners to success (Huitt, 2009). Teachers must have equal interaction with all the students in the class. Mainly a class is divided into three groups; students above the average, average students and students below the average. If teacher is asking questions to make the lesson interactive then he/she must keep in mind the level of the students; So that a student may not feel embarrassment in front of the others. Purpose of such questions is to help the students learn more, such sessions are not for their evaluation. Praise the students and motivate them to take part in the class.

Erase the gender gap

Sometimes in a class students with same gender turn with the interest in some course and lack of interest in some other course. Such gaps can cause a fluctuation in your result. In this situation pay special attention to weaker group, try to involve them in the learning activities and make them realize that they are important part of the class.

Class room architecture

Mostly class rooms are built in a way, where the teacher is the person who needs to catch the entire attention of the class. For interactive learning sitting arrangement across the table or around the table is more preferable, as it will help them to talk about what the topic under discussion and at the same time the back bencher concept will be eliminated from the class (Silverthron, 2006).

Outcome based education

Outcome based education is mainly concerned with curriculum design. It ensures that content, delivery, activities and assessment all are associated to facilitate the students in order to achieve the desired learning outcomes (Willis and Kissane, 1995). It is a very effective way for engineering teachers to keep in-class teaching and learning activities up to the mark. Before starting a course an instructor is asked to prepare a course plan illustrating outcomes and objectives of the course to be taught. It is observed that these plans are effective, if prepared with the help of senior instructors who have the experience of teaching the same course and sometimes the instructors who have experience to teach the same class. Usually these plans and the actual outcomes are compared fortnightly, but to really benefit from this it is suggested to compare the outcome of teaching and learning after delivering every lecture and conducting lab hours; so that if there is any problem of understanding between you and your class, then it can be eliminated at early

stage. Usually it is observed if a student is not easy with a course or instructor in the starting lectures, keeps the same difficulties with his/her till the end of course. But if you help them to solve their difficulties in early phases then they learn better and in return outcomes of your course chase higher.

Problem based learning

To make engineering education more productive, University of Manchester's School of Engineering implemented problem based learning or more precisely project based learning, school wide in 2001 (Crowther, Lennox, Procter, Wood, & Tobbell, 2001). Problem based learning is focused to organize the curricular content around the problem scenarios rather than subjects. Students work in groups to handle these situations without having any predetermined keys. They are engaged with specific situations along with a certain complexity, after analyzing the situation they decide by themselves what they need to learn and what skills are needed to handle the given situation effectively. Purpose of this institute was to produce engineers with sound foundations of engineering knowledge as well as communication skills, and ability to work in team in order to solve the problems. They observed that after completing one year of problem based learning students were more confident of their own abilities, keener to work, better able to work in a group, and had better understanding of practical engineering aspects. Moreover they improved their progression rate from 75% to 86% at the end of first year.

Adult learning theories

There are many adult learning theories in practice e.g., Behaviourist, Cognitivist, Humanist, Social learning and Constructivist (Frank, Gabriel, Kathy, Ron, & Olalla, (2004). Purpose of such theories is to produce behavioural change of students in desired direction, develop their capacity and skills to learn better, become selfactualised, autonomous, model new roles and behavior, and construct knowledge. Teaching impacts learning and in the light of these theories an instructor can better understand the psychological challenges for his/her students and can model their minds according to current requirements.

PRACTICAL EXPERIENCES

Here are some practical experiences of different renowned faculty members of the world famous institutes of engineering and technology.
(Silverthron, 2006) writes his self experiences at University of Texas; he explained different ways to make teaching interactive and also the difficulties he faced while implementing the new methodologies which are different than traditional ways of teaching. He believes, it must be distinguished first what you have to teach the students and what they have to learn by themselves. He says while changing your teaching method from conventional to interactive do not

implement all the changes at once, rather start with small changes and whenever you are going to introduce some new rules, make an announcement about it and elaborate its advantages for students' mental grooming. Therefore students will be able to adopt the new changes and will not consider it torturing. Moreover he adds try to be friendly with your students, and try to know about their difficulties and help them to come out of their problems.

Eric (2012) writes about the changes he brought in traditional way of teaching. He actually changed the teaching to collaborative learning, and he believes in "helping students learn" rather than "teaching" facts and figures without developing any relation with the ideas to solve problems. He realized that students taught in traditional way are only able to implement their knowledge on numerical problems and they are totally hesitant to apply their knowledge to real world phenomena. That's why, it is needed to make them think beyond the bookish problems and let them learn as they are interacting with real world situations. Charles (2013) at Purdue University introduced, Purdue Mechanics Freeform classroom, where students interact with each other and with their teachers online. These classrooms are equipped with hundreds of instructional videos and animations. Moreover there are course blogs where students and teachers discuss online about different problems. Teachers also know about the difficulties of the students from on blog discussion and turn with simple examples in physical classrooms to clear their difficulties. Using this interactive method Purdue University has reduced their engineering course failure rate from 20% to 5%. Elena (2010) wrote some very simple hints to develop interaction in the class by removing fear from their hearts and allowing them easy access to you in the time of their need, which are applied in University of Sheffield. According to the book a teacher must keep his/her contact details updated online, mention officer hours in your online profile, try to learn the difficulty of your students from their body make-up, explain them your role in their learning in very first meeting, explain them clearly about your teaching methods and try to value student's needs. Obviously to bring interaction in the class, you need first to eliminate fear from students' heart and make them realize that your ultimate goal is to help them in learning and you are always with them if they have any difficulty in understanding.

CONCLUSION

Education is not a business to distribute information rather it is a social phenomenon (Donovan, Bransford, and Pelegrino, 1999). It is social until we keep the educational environment interactive; interaction between students and teachers, interaction amongst the students, and interaction of the students and teachers with the industrial experts. Purpose of interaction is to retain the knowledge in students' mind, make them proficient to apply their knowledge to real world problems, help them to express what the solutions they have for the

problems in their minds, and to show them path to implement those solutions. Clarified ideas come after conversation, debate, and negotiation. Interact with the students and try to produce the people who initiate the ideas; as the conversation is the major key to open the locks of technical education in 21st century.

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