

Train the Trainer - an Experiential way to Effective Teaching

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Abstract: In the current era of web, students are flooded with sea of information available on the internet. A teacher should be an efficient navigator who can guide the students to swim in the right direction to achieve their dreams. In this context, training engineering faculty is the need of the hour as most of the faculty would not have undergone formal training unlike other professions. In a scenario where students are losing interest in traditional teaching methods, an attempt is made to improve the efficiency of teaching by making trainers experience the novel methodologies of teaching before they apply them in their teaching methods. One such attempt in this direction was made to enhance the teaching skills of engineering teachers by conducting a workshop on "Effective teaching of Data Structures and Applications". Trainers expressed their satisfaction about the improvement in their quality of teaching that resulted in better understanding of concepts among students.

Keywords- trainer, effective teaching, visualisation

1. Introduction

Employers from IT companies claim that very less percentage of students graduating from engineering colleges are employable. A gap is always felt between the learning and application capability of a graduate. In order to excel as an IT professional, one has to be technically competent and good in leadership skills, interpersonal skills, problem solving ability and innovative thinking. Traditional teaching methods provide limited opportunities for trainers to inculcate these attributes among students. To overcome the limitations of traditional teaching, effective teaching techniques have to be adopted by trainers which help in overall development of the student.

The course "Data structures and Applications" is chosen to train the trainers in effective teaching techniques. Currently, this course is included as a core subject for 2nd year Information Science and Engineering students. It is taught with 4 hours of teaching per week. Data Structures constitutes an important foundation topic in computer science education which many students fail to do well due to the complexity of some of its concepts. Data structures play an important role in deciding the efficiency of an application. Usability of a data structure varies from one problem to another. Students should gain the in-depth knowledge of deciding the suitability of a particular data structure for a given application. This requires a sound understanding of the basic data structures concepts.

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To achieve this, many effective teaching methods are used. These include use of animation tools like VISUALGO which helps in visual interpretation of the concepts. Concepts are further elaborated by taking real life examples which help students to apply this knowledge in developing various kinds of applications. Competitive learning, role play and activity based learning are the other methods employed to make students well versed with the concepts. Assessment is done by conducting written tests, online quiz, individual assignment, team assignment, presentations and mini projects.

All these methods were used in the workshop where the engineering teachers were trained by a senior professor. The goal of this entire process was to make teachers themselves experience the effective teaching methods so that they can adopt these methods in their classroom teaching.

A Light on Data Structures Course

Data structure refers to the way information is organized on a computer. Any application that is developed needs some data to be processed. Right selection of data structure to represent this data can have a lot of impact on its performance. The basic data structures studied by students are:

1. Stack
2. Queue
3. Linked List
4. Trees

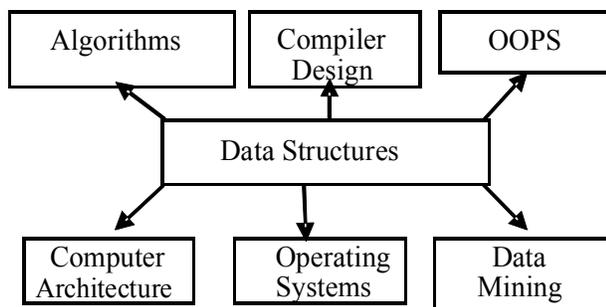


Figure 1 : Courses influenced by Data Structures

Data Structures include more abstract concepts, algorithms and programming ideas. Theoretical presentation is not enough to make students

understand these concepts. Students often feel difficulty in learning process and even exhibit emotional weariness. Hence, a practical approach with new tools and techniques needs to be adopted for teaching this subject effectively. Being a fundamental course, proper understanding of the concepts helps in understanding other courses to be learned by students in future semesters as shown in Figure 1. Hence, this indicates the need and importance of the course for engineering graduates.

2. Related work

According to Richard M.Felder [5], "A class in which students are always passive is a class in which neither the active experimenter nor the reflective observer can learn effectively. Unfortunately, most engineering classes fall into this category". Creating interest and making students interactive in class room teaching is a challenge for any teacher. Withholding the concentration of a student is an art that a teacher should develop. Teaching is a very respectable practice which enriches the students' lives. But making students become creative thinkers and problem solvers is an achievement both for the students and for the teacher. Teaching has to be systematic, informative and comprehensive. Teaching has taken different flavours during the recent years.

The drawbacks of traditional teaching method which is teacher-centered and relies on black board and chalk can be summarized as :

Lacks Student Focused Learning: More emphasis will be on standards, curriculum and passing tests as opposed to student-focused learning. Student-focused learning places value on the student and builds the curriculum around the questions young people need to answer in order to understand the material. Constructivist learning builds on the knowledge students already have allowing them to form concrete associations to new information, which improves retention. Traditional learning is based on repetition and memorization of facts that students care less about and retain at lower rates after testing.

Lacks Emphasis on Critical Thinking: Traditional classroom training doesn't encourage critical thinking skills, the ability to actively apply information gained through experience and reasoning. Instead, traditional training emphasizes the role of teachers as knowledge dispensers and students as repositories. This style of learning doesn't allow students' deeper levels of

understanding required for complex concepts and lifelong learning.

Incomplete practical knowledge: During regular lab sessions, students solve the given assignments using the simple concepts taught in the class. But, they will not be able to apply the learnt concepts to solve real life problems.

Lacks Interactivity : Traditional training emphasizes individual student work which leads to poor preparation of student for his/her future endeavours. As working in teams and collaborating with colleagues is the need of any profession, students receive few opportunities to practice group dynamics under this training model.

Over the past few decades, people have been experimenting various strategies to enhance the quality of teaching in engineering education. Ditcher [1] has stressed upon the reasons and the need to change engineering education. Problem-based learning as an alternative to traditional learning has been highlighted. A Java applet visualiser tool has been developed by Loay et al. [2] that gives visual representation of binary search tree and its operations. The authors report that the tool supported trainers in teaching effectively as well as helped students better understand the coding and algorithms. Survey results in [3] show the use of various visualization tools like DSL, TRAKLA2, VIDSAA, EDM and AETA which inspired us to think about the use and development of new tools for teaching data structures. Blended learning was applied by Xiaojing et al. [4] which is a combination of various teaching methods, project-based teaching, E-learning, course experiment and design , process evaluation and overall evaluation. The authors found that the blended learning model provides more effective and efficient educational experience than traditional teaching method. Students at Brown and John Hopkins University have developed visualisers and testers in Java[8]. Visualisers allow users to interact at runtime with all the methods of a data structure to verify its operation. Testers provide students with accurate reports on the functionality of their programs. The author in [9] has discussed the integration of contemporary teaching effective methods with traditional teaching. Methods like problem-based learning, student teaching and problem solving have been used. The author reports that contemporary teaching methods are more advantageous when integrated with traditional teaching methods.

3. Train the trainer program

The program was organized for five days in which an expert trainer trained the teachers. "Data Structures and Applications" course was chosen for the training program. Teachers were made to experience the way a course should be taught in an effective manner.

Structure of the program

The entire training program is divided into different phases as shown in Figure 2. Background of the topic with abstract definition is introduced to the participants in the first phase. As visual aids and multimedia contribute positively to the pedagogical value of in-class education, simulation tools and animations are used to demonstrate the concepts. Visual interpretation with interactive tools helps students in lucid understanding of the concepts. Visualgo tool which provides an interactive platform on data structures concepts is used. Apart from visualization it also helps in assessing the students understanding of the concepts, hence the same is also used as online judge tool for evaluating the students. Fleming's VARK model states that 60-65% people are visual learners and thus learn best by using pictures and visual aids.

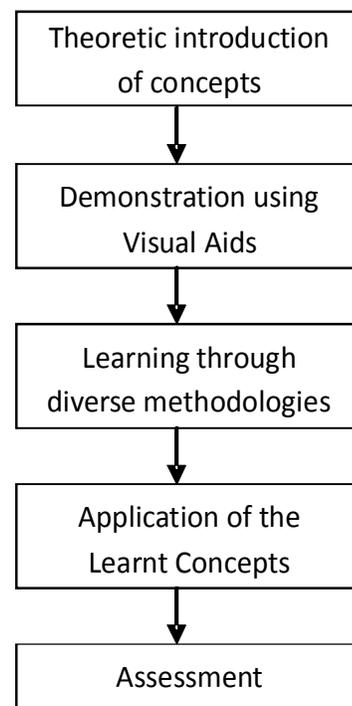


Figure 3 : Steps in Problem Solving

These interactive tools make use of interesting

visualization techniques. One such example is the use of a maze representation. When the user inserts an item in a queue, a truck is shown to throw the item on top of the maze. When extracting an item, the end of the maze opened and the first item falls down. The use of the maze illustrated that items cannot not jump over the previous ones and the fact that in a queue, items are extracted in the order that they came in.

Role play was one of the strategies used to learn the concepts in which the participants themselves were made to enact. One such example is a role play for the concept of linked list. The problem was to store and retrieve the phone numbers of friends. The rules were explained and participants enacted memory locations in an array. They did various permutations so as to create links between themselves. This proved to be a better method for understanding linked lists.

Active student learning is especially important in an introductory data structures course where students learn the fundamentals of programming. This builds on constructivist principles, according to which students become active participants in their own learning process. Instead of viewing learning as passive transmission of information from teacher to students, learning is considered an active process, in which students themselves construct the knowledge by building further upon their prior knowledge. The idea of competitive learning was used which motivated the participants to learn by allowing them to evaluate and improve their programs throughout an assignment by competing their code against instructor-defined code and the code of other participants in a tournament environment. The ability of participants to evaluate their code against others encouraged them to spend more effort in its development.

Once the concepts are understood, there is a need to apply these concepts to solve problems. Normally, students tend to show more interest in learning and problem solving in groups rather than individually. As an IT professional is expected to work in teams with random set of people, the teams were formed in an adhoc manner to take them out of comfort zone. Rather than assigning all problems to all groups each team was given only a single different problem so that each problem can be solved more effectively in a short span of time.

Different steps used for solving a problem are shown in figure 3

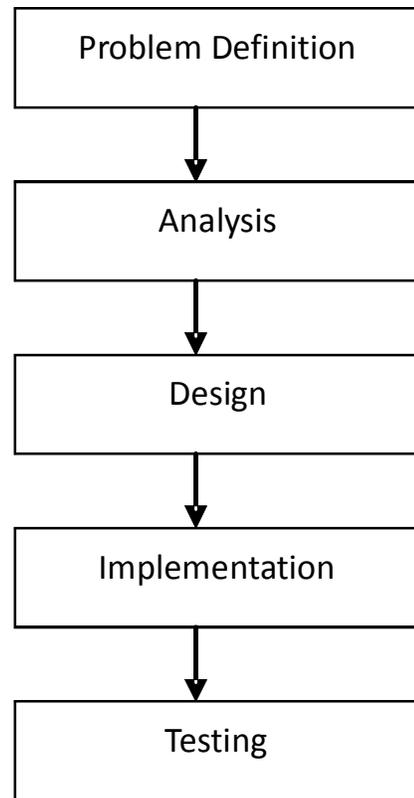


Figure 3 : Steps in Problem Solving

A problem understood clearly is a problem half solved. Participants were guided to analyse the problem statement and identify the required input and the expected output. After an understanding of the problem, they were allowed to present their problem analysis. If any of the teams found difficulty in understanding the problem, they would be guided by the trainer and were encouraged to come up with a solution. This boosted up their confidence in further problem solving.

After completing the assignment, each team was asked to present their work in front of other teams. Audience were encouraged to ask questions during presentation which helped in improving their interaction skills. After the completion of presentation by all teams, written test was conducted individually for all the participants. The test questions were based on the problems presented by all the teams. This compelled the participants to listen attentively to others' presentations also. This was an effective way of understanding solutions to multiple problems in less time. Participants were encouraged to write technical papers related to their assignment and present them in a conference.

Not every student is perfect; neither any student is a failure. Since students are evaluated at the end of teaching of each course, the participants were also evaluated in order to make them realize the fact that evaluation should be fair enough. Assessment was based not only on the final solution but on the understanding of the problem, methodology used in arriving at the solution, presentations and individual involvement in solving the problem. To boost up confidence among below average performers and appreciate the toppers for their problem solving ability, all the scores below the minimal marks were frozen at a minimum score and the rest were accordingly moderated.

4. Impact of the Training Program

The main purpose of conducting this training program is to enable faculty to become more effective teachers which will help them to improve the learning outcomes of their students. Being the participants, the teachers themselves experienced the effectiveness of the methodologies used in teaching the concepts. The faculty were able to appreciate the importance of using current techniques and tools for teaching a course. They could realize the effectiveness of making students work in teams to accomplish a common goal. The program also had the positive effect of inducing research culture among faculty and students.



Figure 4: Participants feedback on training sessions

Faculty expressed their happiness about the training program they underwent. Feedback was collected to know the impact of this program on faculty. The questionnaire included in the feedback and the response from faculty is tabulated in table 1. Also the feedback on different sessions of the training program is shown in figure 4.

Table 1. Feedback Result from Participants

Criteria	Positive Response (in %)
Do you feel the training program will help you in enhancing your teaching skills?	95
Do you feel the methods used in the training program will improve the problem solving skills of students?	90
Do you feel the methods used in the training program will improve the technical ability and communication skills of students?	93
Did the training program meet your expectation?	98
Will you recommend your colleagues to attend the training program ?	96

5. Conclusion

The training program is a small step towards improving the compatibility between the learning and teaching styles of engineering students and teachers. The training sessions strengthened and verified the understanding of the teachers, increasing their confidence and opened up a wider avenue for the trainers to provide quality teaching to students. The strategies used in the training program were found to be helpful in capturing and sustaining the attention of participants thereby resulting in effective perceptual and conceptual learning. As a whole, the objective of supplementing and enriching teachers' own teaching to make teaching-learning more concrete was achieved to a greater extent.

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