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Effective Tutoring with Senior Students' Assistance

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Abstract: In the era of transformation in engineering education, tutorial finds a place as an important teaching-learning tool. Tutorials are small classes in which material from lectures and readings are discussed in more detail. Tutorial classes can be used effectively for emphasizing problem solving which plays a vital role in improving the comprehensive ability of students. Tutorial classes demand more resources in terms of tutors, classrooms and time. Hence, many engineering colleges in India find it difficult to accommodate tutorials in their curriculum. In an effort to address this issue, the idea of utilizing the assistance of volunteered senior students for conducting tutorials was conceptualized and experimented for two courses. The outcome was the successful conduction of tutorial classes, wherein both tutees and tutors were significantly benefitted. Students interacted very well as they were more comfortable with senior students as tutors.

Keywords- tutorial, problem solving, small group teaching, tutee, tutor

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1. Introduction

A tutorial is a method of transferring knowledge and may be used as a part of a learning process. More interactive and specific than a book or a lecture, a tutorial seeks to teach by example and supply the information to complete a certain task. Agroup of six to eight (or even more) students is a far more common tutorial size.Tutorial is an important teaching-learning tool. It helps learnersenhance their intellectual, communication and social skills [1].Normally, a tutor will help a student who is struggling to understand and apply the conceptsin a course.Good tutorial teaching is inspiring, exacting, challenging and fulfilling for tutors and tuteesalike [2]. Tutorial teaching rests upon a combination of scholarly knowledge, practice, and sound common sense.

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 graduand. Tutorial classes can be used effectively to fill this gap. Students are guided during tutorial hours to solve more problems related to the concepts discussed in regular classes. Problems that invigorate the thinking ability of students are solved in tutorials. Students require more attention from instructor while solving problemsbut aninstructor alone will not suffice for tutorial classes. As most of the engineering colleges are short of resources in terms of tutors and timeslots, it was conceptualized to utilize the services of senior bright students as tutors in tutorial classes.

Importance of tutorials and the role of tutors

A tutorial system is a veritable tool for impactful learning by students. Tutorials provide an opportunity for students to engage in a more personal way with course learning. They enable students to clarify basic concepts and provide a comfortable informal environment for better understanding of a course. Tutorials encourage the key development of critical thinking through exposure to a range of perspectives. They provide an environment in which students can practise discipline-specific academic requirements and skills and get feedback on their progress. Also, teachers can get feedback on the progress of student learning. Tutorial system necessarily encourages or stimulates team-based learning among students.

An effective tutorial system is student-centred and student-driven. A tutor plays a critical role in managing students' expectations for the course. The role of a tutor is to support and guide students throughout the semester and to facilitate student achievement at an appropriate academic standard in the relevant course [3]. A tutor should facilitate students to comprehend and apply the newly learned content intelligently. He should interpret and implement the teaching-learning guide lines prepared for each tutorial session and conduct the necessary activities within the time span allocated. Students should be assisted by tutors to become independent and collaborative learners. They should be trained for developing appropriate study skills to complete the course effectively.

Need for tutorials

Many courses in engineering education include abstract concepts, problem solving, designing algorithms and developing 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. An approach where students are more actively involved in the learning process needs to be adopted for teaching such courses effectively. This may not be possible in regular classes due to limited time. Hence, such courses demand the conduction of tutorials.

Tutorial classes were included as part of the curriculum for few courses like "Data structures and Applications", and “Finite Automata and Formal Languages”.Currently, these coursesare included as core courses for 2ndand 3rdyear of Information Science and Engineering. They are taught with 4 hours of teaching per week out of which one hour is used for tutorials.

Data Structures constitutes animportant foundation topic in computer science education, which many students fail to do well due to the complexity of some of its concepts. Being a fundamental course, proper understanding of the concepts helps in understanding other courses to be learned by students in future semesters. Data structure refers to the way information is organizedon 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. 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.

An automaton is a construct made of states designed to determine if input should be accepted or rejected. Finite automata are used in text processing, compilers, and hardware design. Context-free grammar (CFG) is used in programming languages and artificial intelligence. Understanding the theory and limitations of various computing mechanisms enables students to better understand problems and programs. Teaching this course is quite challenging as it is mathematical in nature[4]. So, a need was felt to conduct tutorial classes for this course, where more problems can be solved for better understanding of concepts.

2. Related Work

Teaching is a very respectable practice which enriches the students' lives. Making a class interactive and creating interest among students, is a challenge for any teacher. Withholding the concentration of a student is an art that a teacher should develop. According to Richard M.Felder, "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". Students should become creative thinkers and problem solvers which 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.

Traditional teaching methods have few drawbacks. One among them is the lack of 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. Traditional learning is based on repetition and memorization of facts that students care less about and retain at lower rates after testing. Lack of interactivity in traditional teaching leads to poor preparation of student for his/her future end eavours. Tutorial classes can help to a greater extent to overcome these limitations. Tutoring can produce better learning gains above traditional classroom learning gains [5].Tutor poses problems, asks questions, and provides occasional hints but little explanation. Tutees answer questions, work at problem solving, and engage actively indeliberate practice. Tutor establishes rapport with students and encourages and supports the learning process.

Tutorials demand small classes such that a tutor can give more attention. Teaching in small groups is expensive. Small-group methods can be justi fied only if we can demonstrate that they are used to maximum effect [6]. The importance of Student Centred Learning Groups (SCLGs) has been highlighted in [7] which encourage co-operative learning where students can help each other to work through the questions. Where necessary, the tutor can assist a group or the whole class. Tutors have the opportunity to develop key transferable skills such as communication and leadership, which in turn can enhance their employability opportunities. There is also potential to increase and develop social and academic confidence [8].Group learning facilitates not only the acquisition of knowledge but also several other desirable attributes, such as communication skills, teamwork, problem solving, independent responsibility for learning, sharing information, and respect forothers[9]. Problem based learning can therefore be thought of as a small group teaching method that combines the acquisition of knowledge with the development of generic skills and attitudes. Hence tutorials can be used effectively to emphasise more on problem solving.

3. Our approach

Tutorials were conducted for the courses “Data structures and applications” and “Finite Automata and Formal Languages”. For both the courses, four teaching hours per week are stipulated in the curriculum. Regular classes are conducted in the first three hours and the fourth hour is reserved for a tutorial. This helps in emphasizing problem solving on the concepts covered in the classes. Tutorials are normally conducted for a small class of students. But this requires many tutorial slots when the class strength is large. This is time consuming and resource intensive. Hence, we came up with the idea of conducting tutorials in the right spirit with the available resources.

For the effective conduction of tutorials, the entire class is divided into several groups based on the intelligence level of students. The group size may vary depending on the class strength. Students are grouped such that slow learners are put into one group so that more attention can be given to such groups in making them understand the concepts. Sometimes, students are also allowed to form groups of their own choice according to their comfort.

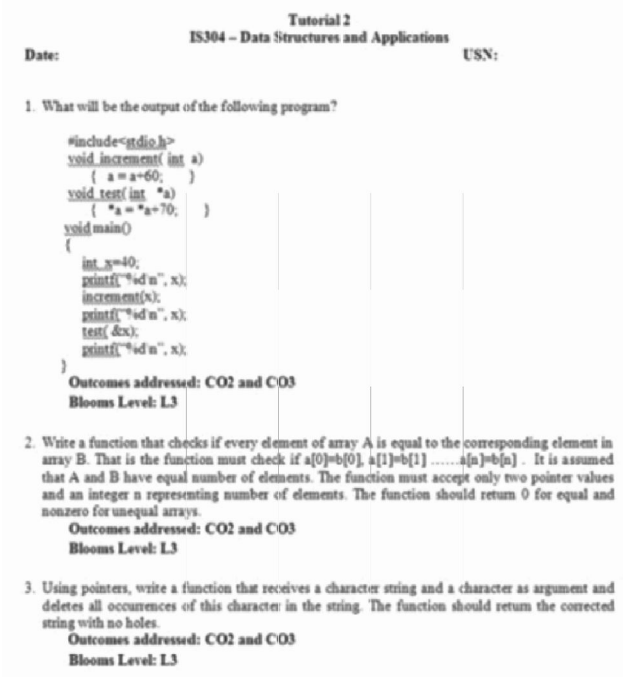
As it is not possible for a single tutor to give individual attention to each group, the idea of utilizing senior bright students as tutors was conceptualized. Senior students were apprised of the whole activity and the benefits they would get out of this. This motivated them to volunteer as tutors, as this was an opportunity for them to improve their skills. The time table is framed in such a way that senior students are free to conduct the tutorials without affecting their regular classes.

Figure 1. Tutor guiding a group of students

For each tutorial class, tutorial sheets are prepared which include programs and problems. The course outcomes and blooms level for every problem are also included in tutorial sheets (Fig 2). Tutors are given the tutorial sheets in advance to prepare themselves for guiding the students in tutorial classes. Each group is assigned with a tutor who consistently guides the same group in all tutorial classes (Fig 1). This helps

tutors to understand the ability of students and monitor the progress of individual students in the group. Students are more interactive as they are comfortable with seniors as tutors. Problems which cannot be solved in tutorial classesare given as assignments. Assignments are verified by tutors of the same group which reduces the burden on instructors.

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. Hence, activity based learning is also used in tutorial classes. In Data structures, each group is assigned with an activity to demonstrate the concepts like stack, Infix to postfix expression, queues etc. Group members discuss with each other and plan to demonstrate the concepts using models, simulation videos etc. In Automata Theory, activities are conducted in tutorial classes to demonstrate few concepts like working of Turing machine and pushdown automata.



Tutorial 2
IS304 – Data Structures and Applications

Date: **USN:**

1. What will be the output of the following program?

```
#include<stdio.h>
void increment( int a)
    {  a = a+60;    }
void test( int  *a)
    {  *a = *a+70;   }
void main()
{
   int x=40;
   printf("%d\n", x);
   increment(x);
   printf("%d\n", x);
   test( &x);
   printf("%d\n", x);
}
```

Outcomes addressed: CO2 and CO3
Blooms Level: L3

2. Write a function that checks if every element of array A is equal to the corresponding element in array B. That is the function must check if a[0]=b[0], a[1]=b[1] ……a[n]=b[n] . It is assumed that A and B have equal number of elements. The function must accept only two pointer values and an integer n representing number of elements. The function should return 0 for equal and nonzero for unequal arrays.

Outcomes addressed: CO2 and CO3
Blooms Level: L3

3. Using pointers, write a function that receives a character string and a character as argument and deletes all occurrences of this character in the string. The function should return the corrected string with no holes.

Outcomes addressed: CO2 and CO3
Blooms Level: L3

Figure 2: Tutorial Sheets

4. Impact of Tutorials

Conduction of tutorials increased student understanding of concepts. This was evident from the marks scored by them in class tests and exams. Tutorials led to more efficient use of both tutor and student time. For accommodating tutorials, contact hours were reduced without loss of content. Tutorials encouraged a more uniform learning process among students. Tutors got a deep understanding of the subject by teaching others. Tutees experienced productive learning and gained confidence in their abilities. They welcomed this approach of tutoring and were found to take more responsibility for their own learning.

The faculty were able to appreciate the importance of tutorial classes for teaching a course. They could realize the effectiveness of making students work in teams to understand the concepts. It helped faculty to establish personal rapport and empathy with students. Faculty were able to use different strategies in tutorials to motivate students and bolster the irconfidence.

Tutors and tutees expressed their happiness about the conduction of tutorial classes. Feedback was collected to know the impact of this program on tutees as well as tutors. The questionnaire included in the feedback and the response from tutees is tabulated in table 1.

Table 1. Feedback from Tutees

Questions	Positive Response of Tutees (in %)
Do you feel the tutorial classes helped youin better understanding of the course?	95
Do you feel the involvement of seniors as tutors helped you to interact better?	97
Were the tutors able to clear your doubts to a certain extent?	93
Did the tutorials contribute for better performance in exams?	91
Would you like to have tutorial classes for other courses also?	95

5. Conclusion

Tutoring with theassistance of senior studentsis a small step towards promoting greater student learning and increasing student motivation towards learning.The tutorial classeswere found to be helpful in capturing and sustaining the attention of participants thereby resulting in effective perceptual and conceptual learning.Studentsalso felt that the pressure during examinations is reduced as they had understood the concepts and had learnt how to prepare for exams from their peers and seniors. Tutorials are surely to be encouraged in providing the best opportunity for studentstolearn both from their peers and from their tutors.

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