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Tutorials Address Individual Needs of Students in Large-group Teaching*

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In this paper, two teaching-learning strategies are identified: one is subject-centred and the other is student-centred. The importance of tutorials in each of these methods is discussed. For subject-centred teaching, the tutorial provides an opportunity for the student to discuss problems, seek opinions, promote understanding, and addresses the individual needs of the students. The tutorial is a discussion session and for its success, each member must prepare himself and participate. The nature of the tutorial problems, the composition of the group, and the size of the group all affect the effectiveness of the tutorial sessions. Various ways of conducting tutorial sessions are discussed and the one likely to produce maximum participation is identified.

1. INTRODUCTION

'ALMOST everybody is concerned with better teaching but only a few worry about effective learning. Yet the emphasis should be placed on learning. In engineering, effective learning measures how well the practitioner has absorbed and can apply the body of knowledge demanded by the profession'—Fred Landis [1].

Small group teaching has always played an important role in teaching and learning strategies of lecturers and institutions [2]. Tutorials, an example of small group teaching, are and have always been an important element which help students immensely in the pursuit of learning.

The history of tutorials dates back to the fifteenth century [3]. Oxford and Cambridge were the pioneers and the beginnings of the tutorial system have been found early in Oxford history. The earliest tutors were not primarily teachers, they were chosen to be personal guardians looking after the overall well-being of the students. In more recent times, the tutor's role has become teaching and tutorials could be described as education that involves discussion and participation.

This paper includes a description of the cardinal principles on which the tutorial system is based and the important factors that help to promote discussion and participation. The roles of both the tutors and the students, and the composition of the group in achieving the desired level of discussion, which are considered key elements of a learning environment, are identified. The physical settings and the various ways the tutorials could be conducted are also described. The experience gained in the conduct of tutorial sessions at the Faculty of Engineering, National University of Singapore (FOE-NUS) and the feedback from students are used as examples to identify the one which, in the opinion of authors, would produce better participation and discussion.

2. TEACHING–LEARNING PROCESS

For teaching at universities, there are two main systems in practice [4]. One is subject-centred, in which the basic teaching is given by lectures supported by tutorials and supplemented by laboratory classes. The other is student-centred, in which the framework teaching is given by tutorials, and the student is asked to attend lectures which are considered to be suitable for his/her abilities and interests. The purpose of tutorials in student-centred teaching is to evoke from the student the greatest intellectual effort of which he/she is capable and to stretch his/her ability to the utmost. The pace and level of teaching is geared to the different degrees of ability of the students and the speed at which their minds move. Besides tutorials and lectures, students are required to perform experiments and projects. Oxford and Cambridge practice student-centred teaching and their tutorial group sizes are small.

FOE-NUS, as with most other univerisities, practice the traditional subject-centred approach to teaching which includes lectures to transfer information, concepts and to create interest in the subject; tutorials to promote understanding and to develop dialogues; and projects (both design and research), academic exercises, special tasks or problems, for which a solution has to be found and implemented. Being an engineering course where practicals are essential, laboratory classes are included to validate concepts and to expose

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students to the various measurement techniques and equipment. Industrial training through short-period attachments to industry is also included to give students an appreciation of actual conditions in industry.

Lectures are considered to be the best way to present materials which may be too complex to understand without oral explanation or too wasteful of time to acquire otherwise. In normal practice, the lecturer will cover the syllabus with lectures only in a broad scope and on principles, and provide examples to make the principles more easily understood. Hence, extensive reading is required on the part of the student around the framework so provided. The student must be an active partner for a satisfactory learning process.

In the earlier years of the course of study, lecture groups can be very large—typically from 50 to 350 students. At FOE-NUS, for example, where the engineering intake into the first year could be as large as 1600 students, the first-year students are divided into four groups of about 400 each for lectures. The lecture is usually pitched at the level of understanding of the average student in the lecture group. It is sometimes not possible to allow any interruption or to promote any dialogue in such a lecture situation. The individual needs of students are left to be addressed in tutorials.

3. ELEMENTS OF THE TUTORIAL

Every student learns by himself/herself, at his/her own pace, stimulated perhaps by others. To overcome some of the problems encountered in lecture situations, tutorials are held in small groups, typically with 15–25 students. These tutorials are example classes linked very closely with the lectures and at which example problems are discussed.

A successful tutorial must fulfil the following objectives:

(i) it caters to the needs of individual students,
(ii) it helps to promote dialogue,
(iii) it provides feedback for the lecturer, and
(iv) it helps the lecturer to maintain personal contact with his/her students and to discover their individual qualities.

Each student is different from another. Each student learns at his/her own pace, sometimes stimulated by competition or by fear (of failure). Individual variations in learning can be taken into account only when the student-tutor ratio is small. The student-centred method of teaching is considered to be expensive and, sometimes, wasteful of the teacher's time if it involves repetition of materials [4].

The success of a tutorial session depends on the co-operation between the students and their tutor, and also on co-operation among the students. It is a team effort—each member of the team must contribute to the best of his/her abilities to the success of the session. Before the commencement of the first tutorial session, the tutor needs to create an awareness of the duties and responsibilities of the students for the success of a tutorial session.

The tutorial is considered to be a learning exer-

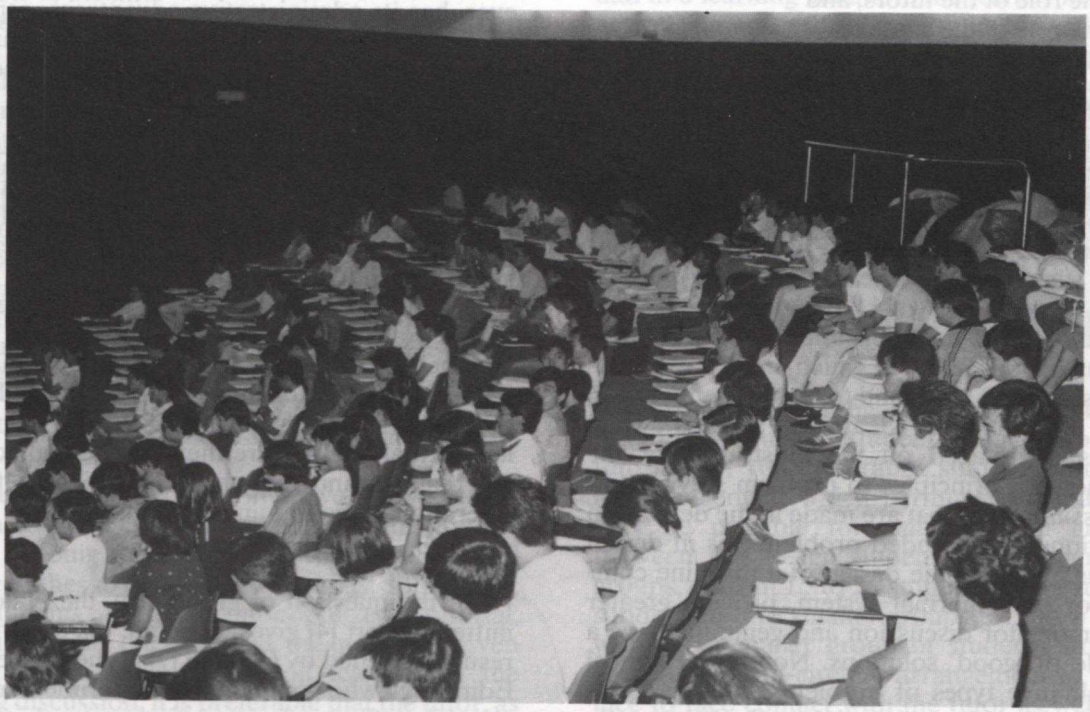

Fig. 1. When students are lectured in large groups, it is difficult to cater to the needs of individual students. Lecture is an efficient means for the transfer of information and, perhaps, to inspire students in particular subjects.

cise, learning by questioning and by enquiry into ever more searching difficulties. The information which passes from the lecturer to the student, perhaps without going through the minds of either, are alien to a meeting of the minds. The tutorial method is a method that enquires, probes and scrutinizes. It is an attitude to learning which perceives the human condition as an endless process of discovery, re-examination, re-evaluation, revision of what we consider we have acquired.

The task of changing the pattern of education from a teaching environment to that of a learning environment is a difficult one since the role and attitudes of the lecturers and the role of students have to change, as the method of transferring knowledge changes.

4. FACTORS AFFECTING PARTICIPATION

Certain salient features, which are considered beneficial for the success of tutorial sessions, have been identified by Powell [5] from a study of 30 university tutors, as reported by Webb [6]. The discussion is considered to be the key to the inclusion of tutorials in the overall strategy of learning. Tutorials are intended to provide the opportunity for students to discuss problems, ask questions and seek the opinions of the tutor to problems which they could not resolve themselves.

The participation in a tutorial has been found to be affected by the following factors:

(i) the type of tutorial problems discussed,
(ii) the nature of the group,
(iii) the tutorial group size,
(iv) the role of the tutors, and
(v) the role of the students.

4.1 *Type of tutorial problems*

Generally, tutorial problems fall into two broad categories: numerical problems and the non-mathematical problems. Some tutorial problems promote more discussions than others. Numerical problems, for example, which are often encountered by engineering or science students especially in their earlier years of study, may involve the demonstration of an application of a principle. Problems of this nature, which may have well-defined solutions, are found to be more effective in helping the students' learning process when emphasis are placed on the illustration of the applications of principles to problem solving and on the assumptions that are made in the derivation of equations. Open-ended problems, as in design problems involving the design of a machine component or of a thermal system, provide greater opportunities for discussion and generally have a multitude of 'good' solutions. Non-mathematical and qualitative types of problems, such as those commonly found in engineering geology, generally evoke a greater variety of opinions and viewpoints and, therefore, can generate a greater amount of discussions. Feedback from students indicate that when tutorial problems are set so as to encourage greater discussion and participation, students not only enjoy the tutorial sessions more, they also learn more from the sessions.

4.2 *Nature of the tutorial group*

Tutorial groups may be formed according to the alphabetical order of the students' names, according to the abilities of students, or in a completely random manner.

At FOE-NUS, as is perhaps the common practice in many universities, the formation of groups is according to the alphabetical order of the students' names. Each of the groups is then likely to include students of varying degrees of learning abilities. This has its advantages as students with better intellectual abilities may inspire the slower learners to perform better. This aspect of the tutorial group cannot be overemphasized, especially in an Asian environment, as students often discussed tutorial problems together informally in small groups. In this way, a great portion of the learning is done in the students' helping and learning from one another. The disadvantage of this method of grouping is that it may be difficult, if not impossible, to set tutorial problems to cater to the needs and intellectual abilities of both the fast as well as the slow learners.

When the students for a tutorial group are selected in a random fashion, the composition of the group is likely to be similar to those formed according to the alphabetical order of student's names. Groups thus formed should include students of varying degrees of intellectual abilities. Maintaining an alphabetical order of names, however, has its administrative advantages, especially for very large classes when searches for particular students are required, as is commonly needed for various purposes.

Students may also be grouped according to their intellectual abilities. In this case, tutorial problems of different degrees of complexity may then be selected so as to suit the needs of the different groups. In this way, it is possible to stretch the abilities of individual students.

In practice, the application of knowledge to perform a job often requires cooperation among members of a group, where each member may have different degrees of intellectual abilities. Tutorial groups of students having different degrees of intellectual abilities are then a better reflection of the realities and this should be taken into consideration in the training of young minds.

4.3 *Group size*

On the question of group size, the Hale Committee Report [4] gives, in detail, the experimental results obtained by Cottrell [7] at the University of Edinburgh who conducted an experiment to determine the effects of group size on teaching efficiency. In the context of his experiment, his conclusion was that the variation of the size of

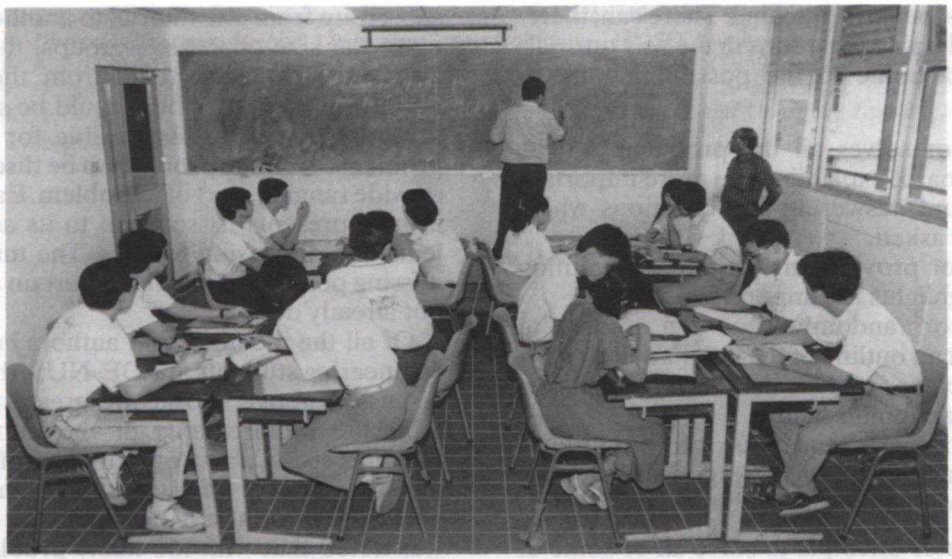

Fig. 2. Leader of a sub-group presents the solution of a tutorial problem. Tutor adds the missing points and highlights the important ones. A learner active exercise.

tutorial groups from 3 to 24 students had no significant effect on their examination performance. Groups of 12 actually do slightly, but not significantly, better than groups of three. Also, according to Osborn [8], the ideal number of people in a discussion session is about twelve. This optimum number may also depend upon the nature of the subject. Most universities, however, will have constraints in their choice of the size of the tutorial groups in terms of availability of staff, classroom sizes and availability, etc.

4.4 *Role of the tutor*

Needless to say, the tutor plays a very important role in the success of a tutorial session. When the tutorial sheet containing the tutorial problems and some references pertinent to the problems are circulated to the students well in advance, students are better prepared and benefit more from the tutorial sessions. The number and type of questions given for any particular session has also been found to affect the effectiveness of the tutorials. The number of questions should not be too high and the type of questions set for the tutorial should cover a spectrum wide enough to cater to the needs of the different intellectual abilities of the students. Open-ended problems are generally found to invoke a greater amount of discussion and participation from students.

It is useful for the tutor, on the very first tutorial session, to clearly state the objective of the tutorial, how it is going to be different from lectures, and how he wishes to conduct the tutorials. Sometimes, a few students may tend to monopolize the tutorial, being always the ones who ask the questions. Even though other students too will learn from the ensuing discussion, it is preferable that the tutor, as far as possible, encourage an even distribution of questions from among the students. The tutors could highlight some of the points which the students may miss.

At the commencement of each tutorial session, the initiation of the discussion is the most important first step. Tutors can encourage the start of discussions by asking a few simple questions. Maintain a healthy environment and the injection of occasional humor has been found to be extremely healthy in promoting informality and discussions.

4.5 *Role of students*

Tutorials are considered to be a learning activity and in a learning situation, the learner needs to be active. Students cannot contribute to the discussion if they have not gone through the tutorial problems before the tutorial and identify the areas where difficulties lie. Students should also be encouraged to find solutions for problems and then discuss these. Collectively, they will benefit more if they spend more time, about 60% to 80%, of the period of the tutorial discussing their problems.

5. CONDUCTING THE TUTORIAL SESSIONS

The physical setting of the tutorial has been found to influence student participation in the tutorials [9, 10]. Preferably, students should sit in an arrangement which permit eye contacts. This may be possible for small tutorial groups of between five to ten students. For larger tutorial groups, of from 15 to 25 students, the group can be subdivided into smaller groups of 5 to 6 students with each smaller group of students sitting in a circular or semi-circular arrangement to maintain face-to-face contact with the tutor as well as with fellow students.

Each tutor is different from another with his/her

own style and scheme of teaching. There can, therefore, be considerable variations in the way tutorials are conducted. Some of the possibilities are as follows:

(i) the tutor solves all the problems on the blackboard, explaining the more important steps and answering any questions which may be asked,
(ii) the tutor provides an outline of a solution and highlights the important points,
(iii) the tutor randomly choose a student to present an outline of the latter's solution for a particular problem and then highlights the important points, and
(iv) the tutor divides the group into sub-groups, with each sub-group responsible for an aspect of the tutorial problems.

When the tutor attempts to solve all or some of the tutorial problems in detail and with students taking notes of what the tutor is presenting on the board, the distinction between the tutorial and the lecture becomes blurred. Similar results are also likely to be obtained if the tutor gives an outline of the problem and highlights the important areas.

A third approach is for the tutor to invite a volunteer from the tutorial group to give an outline of the solution of a particular problem. If there is no discussion, the tutor can initiate by asking questions, seeking the students' opinions on certain aspects of the problem. Among the methods tried at FOE-NUS by the authors, this method has been found to work well in most of the engineering subjects if the tutorial sets are distributed to students in good time. This approach also encouraged students to be more prepared prior to the start of the tutorial, in order to avoid being embarrassed, as any student may be asked to present his solution for the class. Occasionally—and this is especially so with Asian students—it may be difficult to find a volunteer and if someone is randomly chosen to present a solution to a problem, the group may not derive the maximum benefit from it.

Some of the aforementioned shortcomings could be reduced by actively making efforts to involve students more in the problem-solving process. In this approach, the tutorial group is divided into several sub-groups. The number of sub-groups depends on the number of problems set for the tutorial. Each sub-group elects a leader with this leadership role rotating among the members of the sub-group from one tutorial to another. Depending upon the size of the sub-groups, the leaders can also serve as rapporteurs from their respective groups or other members could be selected. Each sub-group is made responsible for a number of problems or, if the problem to be discussed is large or wide ranging, part of a problem. Each sub-group in turn presents its solution to its assigned problems and discussion follows. The tutor fills in the missing points and highlights certain areas, if this is not already done.

Of all the methods that authors have tried with engineering students at FOE-NUS, the last method discussed above shows the greatest potential to fulfil the requirements of the tutorial sessions. Students spend about 60% to 70% of the time talking. The number of tutorial problems set for any particular tutorial session should not be too high. It was noted that with too many problems, students tend to be 'rushed' to go through all the problems and, in so doing, do not spend adequate time on any particular problem. For engineering, three to four problems may be considered adequate and such questions should be selected such that they can promote discussion among students.

6. CONCLUSIONS

- The role of tutorial in teaching-learning strategy has been identified. For subject-centred teaching, the individual needs of students are addressed in tutorial sessions.
- The duties and responsibilities of both tutors and students should be clearly spelled out to derive maximum benefit from a tutorial session.
- To promote better discussion and participation in tutorials, each member must be active and play his/her part, cooperate with others, and show positive attitude of learning.
- The effectiveness of a tutorial session depends on the nature of the tutorial, and both the composition and size of the group. Open-ended problems generate more discussion.
- Of all the methods tried by the authors at the Faculty of Engineering and the feedback from students show that the presentation of the solution of a tutorial problem by students, where the tutor highlight the important points, draws maximum participation.

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