PROMOTING AN ACTIVE LEARNING ENVIRONMENT WITHIN A CONGESTED CURRICULUM

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Abstract *¾ Undergraduate engineering curriculum tends to be heavy in many universities as a large number of technical, fundamental and humanity modules are usually covered. With a heavy curriculum, students would hardly find time to digest the course materials and hence are often unable to apply the concept learned in the junior level modules to the senior level modules. This paper presents a case study on the successful promotion of active learning among students without overloading them in a congested curriculum. The conduct of active learning tutorials is illustrated using a Third-year civil engineering module as an example. The adoption of active and passive learning teams in the same tutorial group is found to be effective in motivating students to learn by themselves with no increase in their workloads.*

Index Terms ¾ Active learning, curriculum, geotechnical engineering, tutorial.

INTRODUCTION

With rapid development in engineering technology and the emphasis on broad-based training, there are many technical, fundamental (mathematics and basic sciences) and humanity modules to be covered in an undergraduate engineering curriculum. In addition, many of the technical modules are expected to be covered to great depths so as to include the latest technical know-how and development in a particular technical area. Nowadays, undergraduate engineering students often face a very congested curriculum and hence have little time to understand and digest the significant amount of course materials. Under such scenario, students tend to acquire an 'optimal' learning skill and habit in which little time would be spent on understanding the fundamental concept but aiming to achieve a good grade with minimal effort. Although students generally score well in their assessments, many of them lack a basic understanding of the subject matter and are often unable to apply the knowledge and concept learned in the junior years to modules in the senior years.

To encourage students to put in more efforts, some faculty members choose the 'continuous assessment' mode such that a very high percentage of grading is given to the many quizes and course work assignments given throughout the module. This approach generally works well as students definitely have to spend more times in order to obtain good grades for the module. Sometimes students termed such 'continuous assessment' modules as 'continuous harassment' modules as great deal of efforts have to be put in throughout the module. However, students tend to spend too much time on such modules and often neglect modules that demand considerably less assignments. If all the modules incorporate the 'continuous assessment' mode, students obviously cannot cope as it is not possible for the students to spend great efforts on all modules in a curriculum that is already heavy.

Under the above scenario, it is often difficult to stimulate the interest of the students to acquire the fundamental knowledge of a subject as many students solely aim at scoring good grade without much understanding of the subject matter. In this paper, a case study is presented on how to promote active learning without overloading the students in a congested curriculum. An undergraduate core module in geotechnical engineering in the Third-year civil engineering course at the National University of Singapore (NUS) is used as an illustrative example to explain the process.

ACTIVE LEARNING TUTORIAL

At NUS, an undergraduate module typically consists of 2 or 3 lecture hours per week. For most modules, all students will attend common lectures in large lecture theatres and they are then divided into groups for their experiment and tutorial classes. Each tutorial group would consist of about 25 students who attend tutorial classes typically once in two weeks for a module. Traditionally, tutorial classes are problem-solving classes in which the faculty member would present the solutions to the tutorial problems given in the lectures. Students then raise questions to clarify the solutions presented in the tutorials. Owing to a heavy curriculum, many students at NUS do not have time to attempt the tutorial questions before the class and often 'blindly' accept the solutions presented. Students usually ask relatively simple and straightforward questions to clarify the materials covered in the lectures and the solution procedures. They normally do not attempt to ask questions that are related to the fundamental understanding of the subject matter. Thus the tutorial classes tend to be simply one-sided with the one-way transfer of knowledge from the faculty members to the students and it is not sure the extent of knowledge the students have managed to absorb from the classes.

In view of the above, the Faculty of Engineering had recommended a change in the conduct of tutorial classes

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several years ago. The amount of course materials to be covered in a module is reduced to enable faculty members to present the solutions for worked examples in normal lecture hours. This aims to leave ample time for discussions and interactions during tutorial classes. Discussion topics are to be given by faculty members one or two weeks before the tutorial classes. This results in an improvement in the level of discussions and interactions during tutorial classes. However, it is noted that only a small perecentage of the students take part actively in the tutorial classes while majority of the students do not come prepared and remain fairly inactive during classes. These students often cite heavy workloads as an excuse and they have been spending a great deal of time in preparing quizes and homework assignments for all the modules.

For the Third-year civil engineering undergraduate module in geotechncial engineering, the situation is no different from other modules in which many students cite heavy curriculum and do not come prepared to discuss actively during their tutorial classes. There are about 200 students sitting for the module and they are divided into 8 tutorial groups each of about 25 students. The students had learned the basic soil mechanics theories such as shear strength and consolidation of soils in their Second year. It is noted that many of them are not able to apply the basic theories effectively in the goetechnical engineering module which mainly deals with engineering applications such as slope stability and retaining structures.

In view of the situation and the heavy workloads of the students, an innovative tutorial system is implemented to motivate students to take part actively in tutorial classes. In order to lighten the students ' workloads, students from each tutorial group is subdivided into three teams. During a tutorial class, one team will become the active team such that its team members would initiate the discussions under the leadership of a team leader. The team leader plays the role of coordinator by distributing the workloads among members and arranging the order of presentations. He or she would not need to spend much time on the assignment as long as he/she can manage to mobilise all team members to make their fair share of contributions. During tutorial classes, some members from the active team will make a presentation. This is followed by questions and discussions from the other two teams which are the passive teams for the given tutorial class. This enables the active team members to realise the view points from others and able to understand the subject matter further by answering the queries raised by fellow students. After the discussions, the active team would submit a short report to cover the essential and important points of the topic and distributed it to the whole class by e-mail. The active teams for the tutorial classes are chosen by rotation such that every team has an opportunity to cover different activities.

Depending on the nature of the activities, various tutorial formats are applied to different situations. The following sections provide an insight on the conduct of the tutorial classes in different formats to encourage students to take part actively in the tutorial without overloading their workloads. In fact, students will be given the schedule of their tutorial assignments and their involvement as active teams in the tutorials right at the beginning of the course so that they can plan for their schedule. The leaders of the respective active teams would have sufficient time to coordinate the preparation of active learning tutorials accordingly.

DISCUSSION TOPICS

Discussion on specific topics during tutoirals is found to be the most effective way of motivating students to learn by themselves and hence developing a self-learning habit. About 25% of the tutorial classes are devoted to discussions on prescribed topics. As an example, there are 4 topics to be discussed under the subarea of slope stability. The topics may include importance of shear strength parameters in slope stability analysis, effects of water on slopes, effects of shape of slip surfaces and the use of total and effective stresses in slope stability analysis, and bioengineering for slope protection and erosion control. These topics represent a wide selection of important points for consideration in slope stability analysis that practicing engineers need to be aware of. As there are eight tutorial groups, 2 groups will share a common discussion topic and this arrangement provides some competition spirit between the active teams of the tutorial groups that share the same discussion topic.

The students are given a completely free hand on how to approach the discussion topic and they are simply informed that the active team of the tutorial group needs to make a 15-minute PowerPoint presentation to cover the important aspects of their discussion topic. The students are advised to use the textbook and lecture notes as the starting point but strongly encouraged to refer to reference books, published papers and to search for relevant materials on the World Wide Web. They are free to discuss among members and obtain ideas from fellow students. When such discussion format was first put forward three years ago, common questions posed by the students often included ‘what should they do’, ‘what are the expectations’, or simply ‘can you tell me what to do’. The students were informed that the process is very open-ended and it is up to them to make their best efforts to impress the faculty members and fellow students. Once the first batch had completed the active learning tutorials, less questions were raised subsequently as they generally find out more from their seniors as well as from previous sample reports.

During a tutorial, students from the active team will first make a 15-minute PowerPoint presentation. The students from the passive teams will then raise questions and concerns and the active team members need to answer them. As Asians are generally less outspoken than Europeans or Americans, the faculty member will have to ask the first few questions during the first tutorial. The faculty member then

continues to encourage the students to ask questions and motivates the students by informing them that asking questions is often the best way of self-learning. After the students have more or less warmed up to the situation, they have no problems of raising queries such that subsequent questions and discussions become more lively and constructive. The active team students soon learn that they should look at a given problem from a wider angle or should have gone deeper on certain aspects of the discussion topic.

Although the tutorials generally progress rather slowly at the beginning, it is found that the time for the 50-minute tutorial is insufficient as many interesting and constructive questions still keep coming even after the tutorial time has reached its end. Upon feedback from the faculty member and passive team members, the active team is asked to prepare a short 4-page report plus figures on the discussion topic and submit it by e-mail to the faculty member within one week of the tutorial class. Students are informed that the reports will be graded as a small part of their course assessment. The team leader is requested to report if any of his/her team members has not been active or never contributed to the process. Active teams who have made useful and interesting presentations are encouraged to post their PowerPoint files on the class Intra-Web so that they can be appreciated by all students.

The faculty member would review all the 8 reports, made necessary modifications, fix the mistakes and highlight the important points in the reports. Reports with serious technical errors would be returned to the students for re-submissions. If feasible, reports on the same discussion topics may be combined to provide a coherent and wide coverage of the discussion topic. These reports will be e-mailed to all students in the class which is informed that some of the materials will appear in the quizes and examinations. Thus the students should read the reports and take note of the important points.

It is generally found that the above approach is effective to motivate students to take part in the discussions actively. The students are able to acquire the fundamental concept and relevant knowledge in an interesting and exciting way as they are the ones who formulate the process and the faculty member is only a catalyst in the process. As there are 4 discussion topics to be covered by the whole class and the reports from the active teams are available for everyone, the students are able to appreciate a wide spectrum of topics that are useful in geotechnical practice through team work with relatively little efforts from an individual. In effect, students are informed that group efforts rather than few individual efforts are very much appreciated and this factor is an important consideration in the grading.

USE OF COMPUTER SOFTWARE

Nowadays, the use of computer software is very common in all engineering disciplines. Sophisticated computer programs are available commercially. The users simply use the programs as black boxes without much understanding on the concept and process of the analysis. For the geotechnical engineering module, students are also given opportunities to use computer programs to analyse various geotechnical engineering problems. As an example, all students would be required to perform a computer experiment on slope stability analysis using data from actual field case histories to enhance their understanding and to appreciate the practical aspects of the problem as well as the pitfalls of using computer programs blindly.

In addition to the above, active teams from selected tutorial groups are asked to run computer programs using a commercial software on retaining structures. Each team is given some sample input to start with in order to save their learning time. The boundary conditions of each group are different so that all the combined output form a comprehensive interpretation of a given retaining wall problem. The objective of the exercise is not to train the students to use the computer program to handle stability and movement analysis on retaining structures. In fact, the main aim is to enable the students to appreciate the possible pitfalls of using computer software package as a black box. Through the careful design of the retaining wall problem, the active teams are asked to identify the problems of using computer software arising from the assignment for their own team. The active team leaders then sit down together to exchange notes and to put forward a short common presentation on problems of using computer software during a common lecture. This would enable other students that are not involved in the computer analysis to readily appreciate and identify the problems of using computer software package simply as a black box.

SITE VISITS

Visit to sites is an essential and useful component of civil engineering curriculum. Through the site visits, students are able to appreciate and visualise construction methods and difficulties more readily. For a large class of 200 students such as the one at NUS, it is merely impossible to arrange the whole class to visit a site at one go. For the goetechnical engineering module which involves slope stability and retaining structures, students are given up to four sites to visit. It is compulsory for the respective active team members to visit the site. Other students can take part in the visits if there are vacancies and the site conditions allow. The students are encouraged to take as many photographs as possible and actively discuss with site engineers on the construction techniques and problems at the site.

The active teams would then make PowerPoint presentations on the sites they visited to the whole class during appropriate lecture classes. They are asked to present the essential aspects of construction, highlight problems faced at the site and recommend probable preventive and remedial measures to the construction problems. The students are usually excited about the site visits as these are

rare opportunies for them to appreciate the practical aspects of the module. Without the need of pushing or motivation, they generally prepare well and their team spirit is strong. The students are very keen in making an interesting presentaion on the site visits as they often incorporate creative ideas and innovative animations to illustrate their points. Students who do not have the opportunity to visit the sites are able to appreciate the presentations and raise meaningful questions on the practical aspects of the module.

The incorporation of site visit presentations by the students themselves as means of introducing practical aspects of the module can be considered very successful. The students from the active teams not only manage to acquire practical construction know-how by themselves and are able to communicate to their fellow students in an effective and stimulating manner. By presenting photographs obtained from several sites, a wide spectrum of construction methods and techniques can be covered and the students mutually benefit from the presentations substantially without having to go to all the sites.

NUMERICAL EXERCISE

In order to score well in tests and examinations, students always drill on solving numerical exercises by attempting the tutorial numerical questions and past year examination questions. They usually feel very uncomfortable if the solutions to numerical questions are not demonstrated in the classes. This is especially so under the new tutorial systems where numerical problem solving is only demonstrated by the faculty staff during lectures. The students very often comment on the teaching evaluation that problem solving has been insufficiently demonstrated in the lectures and tutorials and suggest more time should be devoted to this and more problems and the solutions should be given to the students.

To fulfill the students' wish, the active team self-learning mode comes in handy. Selected active teams are requested to prepare sample solutions to given numerical problems and they are requested to present the solutions with emphasis on fundamental understanding of the problems to fellow students in selected tutorial classes. The passive team students will then query the solutions presented with an aim to discuss the concept and to further enhance the solution technique. Thus all students are able to learn from each other. After the tutorial classes, sample solutions are posted on the class IntraWeb for the reference of all students. However, students are reminded that the solutions may not competely correct as they were worked out by the students and it is the responsiblity of individual student to check whether the presented concept and solutions are correct or not. The students find this useful as they have plenty of opportunities to acquire good numerical problem solving skill.

DISCUSSION

The different styles of conducting active learning tutorials to cover various aspects of a module such as discussion topics, numerical problem solving, use of computer software and site visits are found to be effective in motivating students to learn independently and from each other. The adoption of active and passive teams in a tutorial group enable students to spend less time in preparing the tutorials as only the active teams need to prepare the tutorial before hand. On the other hand, the passive teams need only to provide relevant feedback during the tutorial classes to enable the active teams to finalise their reports. Without an increase in their workloads, the students are interested to learn independently and take part actively in discussions during tutorials. Their feedbacks suggest that such active learning tutorials are beneficial, interesting and the approach is innovative. They generally like the ideas and after the initial period of getting use to the new tutorial styles, majority of the active team students contribute their best efforts. There are still a small perecentatge of students who do not like to take part. The team leaders are encouarged to report such persons and these students would not be awarded the grades for the group reports. This is found to be effective in keeping the number of inactive students to a minimum. With the successful adoption of active learning environment, students find that they are able to acquire fundamental concept independently and capable of retaining the knowledge more readily.

The active learning tutorials can be considered successful in motiving students to learn independently and cutivate interests in a module. However, it is noted as far as tests and examinations are concerned, many students still stick to the style of purely hard work or memorisation of procedures to tackle the assessment. Although the open-book examination format has recently been incorporated in the geotechnical engineering module, students still find it rather difficult to apply what they have learned in the active learning tutoirals in the examinations and tests. Thus further efforts are needed to incorporate a complete learning and assessment system so that students not only learn actively during tutorials but also able to apply and demonstrate their knowledge during the tests and examinations.

CONCLUDING REMARKS

The adoption of active learning tutorials is found to be effective in motivating civil engineering students to learn their goetechnical engineering module independently and from their fellow students. By varying the style of conducting tutorial classes to suit different aspects of the course module, students find the tutorials interesting and are willing to contribute actively in the discussions. Not only they achieve effective self-learning technqiues, the students realise the benefits of learning from each other. The adoption of active and passive learning teams and the rotation of active teams in the tutorial groups form a good approach as such system does not overload the students and

also achieves the maximum effect of mutual and self learning.