AN EXPERIENCE IN LARGE CLASS TEACHING WITH ONLINE LEARNING

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ABSTRACT

At the Nanyang Technology University (NTU), Singapore, enrollment of engineering students is more than eighteen-hundred each year. All the first-year engineering students (freshmen) are required to take the common subjects like engineering mechanics in their first academic year. The course is taught in the conventional lecture-tutorial paradigm. There is common lecture for all the students in a huge lecture theater. The students are then divided into smaller tutorial groups of about 25 each, for problem solving and discussion. There are more than 20 full-time faculty members (called the course tutors) involved in conducting the weekly tutorial sessions and marking of the quizzes, and another 20 graduate students involved in marking the homework assignments. Over the years, with growing student numbers, the diversity of backgrounds and levels of understanding of the students also increased. It has been the author's experience that the regular lecture-tutorial sessions are not enough to cope with the students' queries. This paper describes the author's experience in teaching such a large class using an author-developed courseware IITS and NTU's online learning platform Edventure, customized based on the commercial platform Blackboard.

KEY WORDS

Passive teaching tools, multimedia courseware, computer-based interactive tutoring, virtual intelligent guidance, self-paced learning, non-linear access, videoed lecture.

INTRODUCTION

Multimedia has great potential in engineering education (McCuen and Chang 1995). The possible applications of multimedia are almost unlimited given its current capabilities. The success of multimedia application to engineering education, however, lies in the development of good computer-based teaching packages (Easa et al 1998). It is widely accepted that there is a need for good engineering education courseware (Denton 1998). The falling power to cost ratio of personal computers and improved quality of multimedia software has made it within the reach of the teachers/developers and the students/users. Educational courseware can offer pedagogical improvement on the traditional lecture-tutorial-laboratory paradigm (Burton 1998). Multimedia-based education courseware has several advantages. Multimedia is better than the traditional methods because it stimulates various senses (Jesshope et al 1998). Interactive multimedia courseware allows the students to explore in sequential manner or to move about different topics, reviewing a topic several times if necessary and skipping

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others. This approach is known as nonlinear access, and it gives the students the freedom to proceed at their own pace (Koeha 1995). The courseware can be designed to meet the needs of each student with different levels of understanding. From the students' point of view, multimedia takes away the boredom of passive lecture notes and brings in diversity through the interactive nature of the media.

The teacher would be the best developer because of his/her familiarity with the teaching material (Hotchkiss 1994). The biggest bottleneck in the use of multimedia to engineering education is the initial time investment of the teacher. His/her worry is whether the efforts would be recognized, as in most engineering universities, academic career development is linked to research and publications. However, it is expected that more universities would recognize the importance and cost benefits of multimedia education courseware and the effort involved in developing such courseware.

This paper describes the author's experience in teaching a large class of about 1800 first-year common engineering students using an author-developed courseware, Intelligent Interactive Tutoring System – Engineering Mechanics, (Gupta and Soh 2000), supported by NTU's online learning platform Edventure, customized based on the commercially available Blackboard Academic Suite (Blackboard Inc, 2006).

MOTIVATIONS

At NTU, the first course Engineering Mechanics - Statics is taken by more than eighteen-hundred first-year common engineering students in the first semester of each academic year. The course is taught in the conventional lecture-tutorial paradigm. There is a common lecture for all the students in a huge lecture theater (see Figure 1). The students are then divided into smaller tutorial groups of about 25 each, for problem solving and discussion. Ideally, the number of students in each tutorial group should be fewer, but looking at the size of the student population and constraint on the staff strength, this is the best one could get. There are more than 20 full-time faculty members involved in conducting the weekly tutorial sessions and marking of the quizzes (called the course tutors), and another 20 graduate students involved in marking the homework assignments.

Figure 1. NTU's main lecture theater.

Tutorials and discussions are essential in reinforcing students' understanding of the lecture materials. This is all the more important when there are more than 1800 students in the lecture class. During the regular weekly tutorial sessions, the students are given sheets of problems to attempt and discuss with their respective tutors. Over the years, the student number has grown and the students come with diverse backgrounds with different levels of understanding. It has been the authors' experience that the regular lecture-tutorial sessions are not enough to cope with the students' queries. The tutors would normally find students queuing outside their offices (after the regular weekly tutorial sessions, especially nearer the examination) with similar questions. This significantly increases the tutors' teaching workload as they have other courses to lecture and/or tutor.

The situation has been resolved through a two-pronged approach. First, a computer-based tutoring system to supplement the conventional lecture-tutorial sessions has been developed by the author. The main aim of this courseware was to provide the students with a self-paced intelligent interactive tutoring system which tries to mimic the basic tutoring; thus, allowing the tutors to spend more time in discussing the fundamentals during their regular tutorial sessions. Besides, NTU campus is fully networked (wireless) with all the student dormitories in the campus halls of residences linked to NTU Intranet and the Internet; thus enabling the students to study at any place and time. In this way, the better students could go through the course materials faster and the weaker students could spend more time on reinforcing their understanding of problem solving. In addition, the tutors could also spend more time during the regular tutorial sessions to explain the fundamental concepts in greater depth so that the better students would not be bored by the "simpler" discussions for the weaker students. The average students would also benefit from these "deeper" discussions even though they have generally been quite happy with the regular lecture-tutorial sessions.

The second solution was to video tape all the lectures. These video clips were than linked with the lecture materials and uploaded on the online learning platform Edventure (Edventure 2006), customized by NTU based on the Blackboard Academic Suite. Students could than access all the lecture videos and materials as and when needed. In addition, Edventure has a discussion board for the students to discuss their problems with their tutors and fellow students, and there are also online quiz sets for the students to test their own understanding. In this way, Edventure supplements the author's large class teaching with online learning so that each student could learn at his/her own pace and review at their convenient time/location.

RELATED WORK

There is some commercially available software for Engineering Mechanics, but they did not quite meet our main requirement of intelligent guidance/interactions. For example, the Multimedia Engineering Statics (Gramoll et al 1996) comes as a CD-ROM and is expected to be used with any standard textbook. The CD tried to explain the concepts of engineering statics using multimedia; however, the students are expected to understand the questions by looking at the solutions. It lacks interaction with the students as there is no input from the students. There is a simulation mode where the students can change the data and see its effect. Unfortunately, this is of limited help to the students in learning the concepts as intelligent interaction plays an important role in learning (Collins et al 1989).

There is another Interactive Software (Staab and Breeden, 1996) which comes with the widely used textbook "Vector Mechanics for Engineers" (Beer and Johnston, 1996). This software has a quiz section where the students are expected to enter their answers. The students have three chances to get it right, and if not, the correct answer is displayed. At the end, the students have the option to look at the solution. The software is interactive, with some theory presentation and animated graphics; however, the students do not get any guidance in solving the problem. One can only learn by looking at the solution and thus, lacks any intelligent interaction in the learning process.

IITS FOR ENGINEERING MECHANICS

Objectives

The following were objectives of IITS:

- The system should be user-friendly. If the system is too complex, it will probably never be used.
- The students should be able to use the system at their own pace i.e. they will not be forced to go through a certain fixed path. They should be free to go through different chapters, topics and/or problems allowing them to proceed at their own pace and level of understanding.
- The system should be intelligent and interactive, and not merely a fancy electronic page-turner. The students should be able to solve the problems interactively, and if necessary, guided intelligently.
- The system should be intelligent enough to mimic the actual tutoring by providing helpful hints to the students in solving the problems.
- The system should be easily portable and accessible.

With these broad objectives, the framework of IITS was developed.

Framework

The learning process in IITS not only covers conceptual skills, but also reinforces both cognitive and procedural skills. The system allows the student to learn the concepts through examples, and then acts like a virtual tutor providing hints and guiding the student towards the correct solution. The system does not give away the answer/solution, hence reinforcing the process of learning.

IITS has the following modules:

- ***Chapters:*** The course has been divided into eight chapters. Each chapter has a *Topics*, *Problems* and *Frequently Asked Questions (FAQ)* module.
- ***Topics:*** In the *Topics* module, various topics of the chapter are listed. The students can click on any topic in the chapter to review the basic concepts. There is sufficient detail on each topic, yet without any lengthy and overbearing text discussion. Each topic is linked to an example problem. The student can go straight to the example problem, if desired.
- ***Problems:*** The tutorial problems are listed in this module. The students can go to any problem by clicking on it. The students are expected to solve the problem step by step. If the value they entered is wrong, the system acts like a virtual tutor and tries to

guide the students toward the correct solution without giving away the answer. It is expected that this pedagogical approach will reinforce the students' learning process. If the students still fail to get it right, they are advised to revise the chapter/topic by going to the relevant review page by clicking on *Topics*. Since the review page is linked to the example problem, the students can re-study the example problem when needed, and then continue with the tutorial problems.

- ***Frequently Asked Questions (FAQ):*** Every *Chapter* has its frequently asked questions that are anticipated to be common to most students. This module lists these anticipated frequently asked questions. Every question is linked to explanations and examples for better understanding.

The system has been designed to be user-friendly, allowing the students to go through any chapter, topic or question any number of times and to skip any undesired material, hence allowing the students to learn at their own pace. The problems were designed to be solved via intelligent interaction between the students and the system, and the students are encouraged to learn by solving the problems through the *Help* prompts without the complete solution.

Implementation

IITS was developed using Authorware4.0 (Macromedia, 1997). The authors found Authorware4.0 to be very useful in implementing their requirements, especially when the executable version of IITS does not require Authorware to run.

IITS was designed bearing in mind the most basic personal computer system. The hardware requirements are 486 or better PC with VGA monitor capable of displaying 256 colors, about 10MB free hard disk space, and Windows3.1 or later version. The system is best viewed on 800x600 resolution.

Parts of IITS have been uploaded on NTU's online learning platform Edventure, according to teaching needs. Edventure is a NTU online learning platform customized based on Blackboard Academic Suite, for better accessibility by large class sizes. The full version IITS was produced by Pearson-Prentice Hall, Singapore, as a CD-ROM.

EDVENTURE

Edventure is a Blackboard-based online learning platform, customized for NTU's computer (wireless) network to support large-class teaching. All NTU students could access, as and when needed, all lecture materials and video clips of all the courses they are registered for.

Figure 2. Edventure's main menu

For the course Engineering Mechanics - Statics, all the author's lectures were video taped, and the video clips were linked with the lecture/tutorial materials and uploaded on Edventure. In addition, Edventure has a discussion board for the students to discuss their problems with their respective tutor and fellow students.

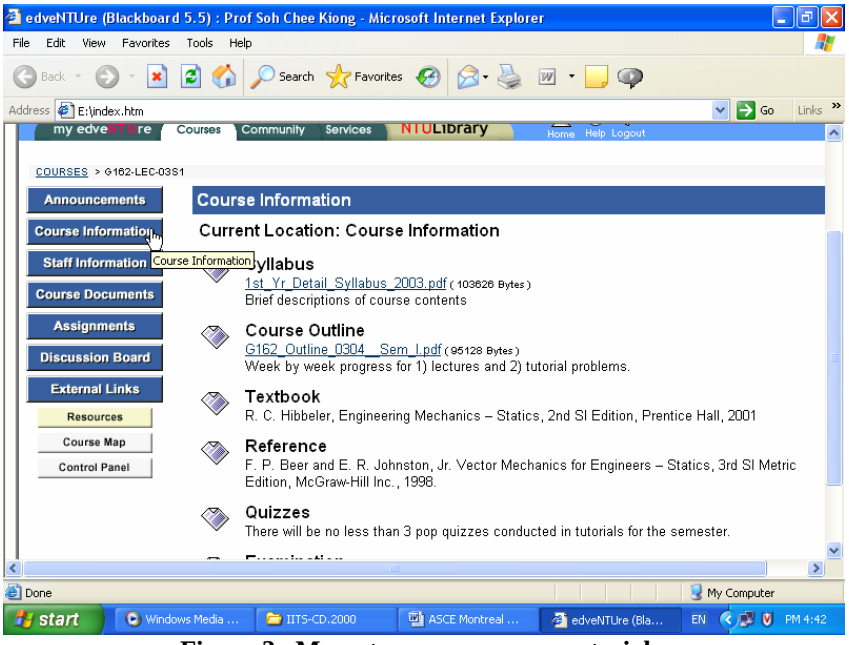

Figure 3. Menu to access course materials.

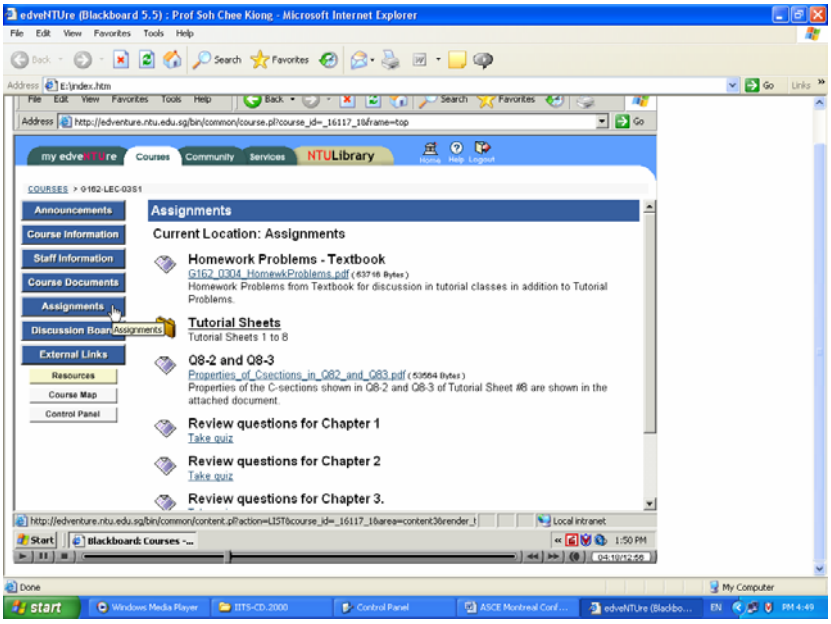

Figure 4. Menu to access tutorial materials.

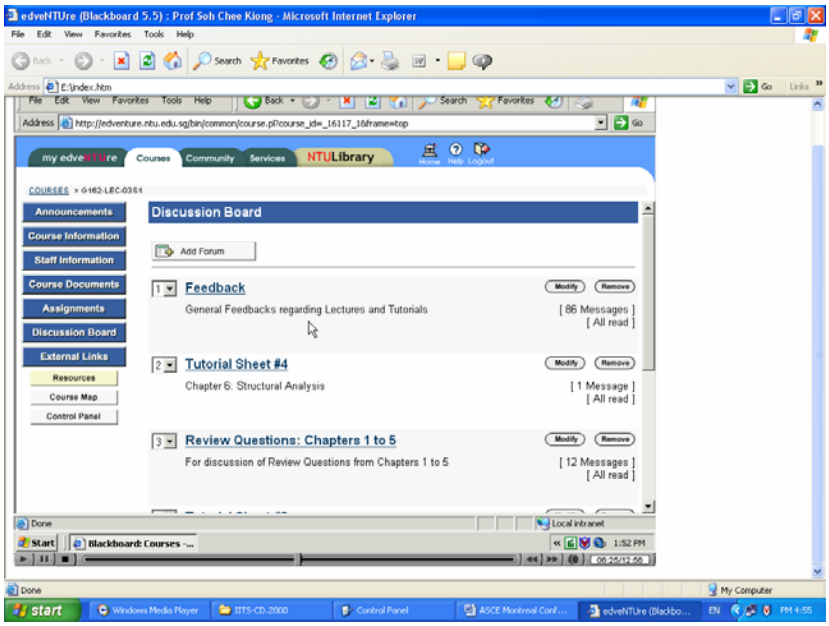

Figure 5. Menu to access discussion board.

The course instructor has full control over the use of the materials he/she uploaded on Edventure, including monitoring of each student's usages and setting/marking of online quizzes. In addition, there is a virtual classroom where the author could conduct online discussion with his students, if necessary. Through all these features, the author found Edventure to be able to supplements his large class teaching where each student could learn at his/her own pace and review at their convenient time/location.

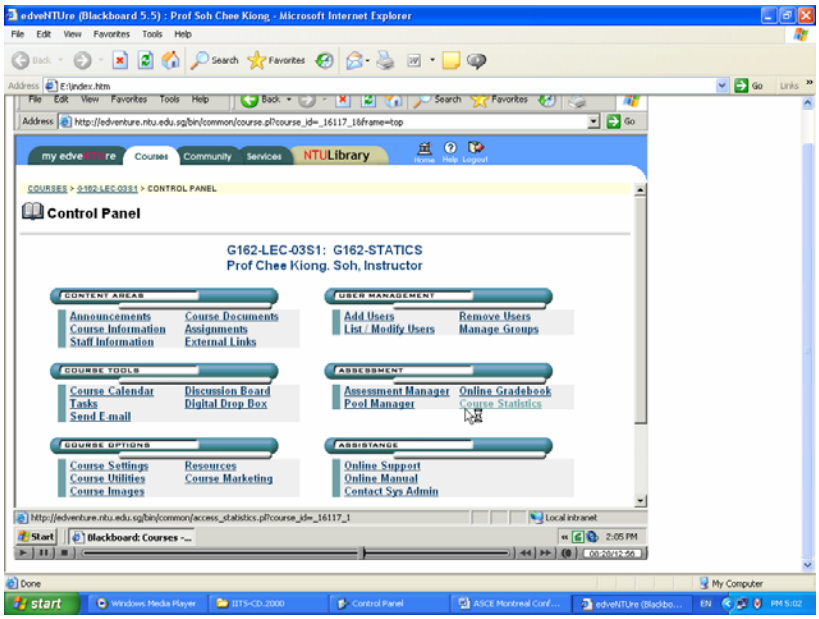

Figure 6. Menu to access control panel.

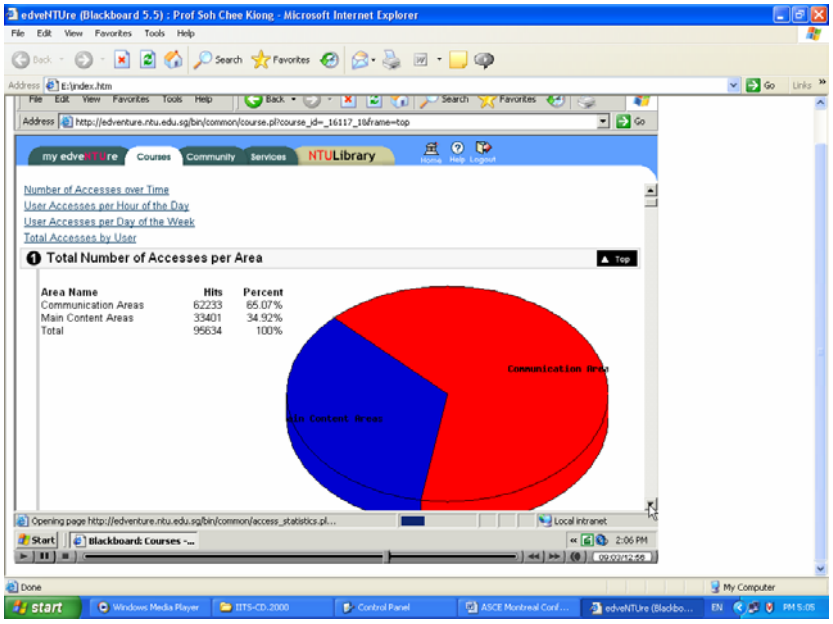

Figure 7. Menu to monitor student usages.

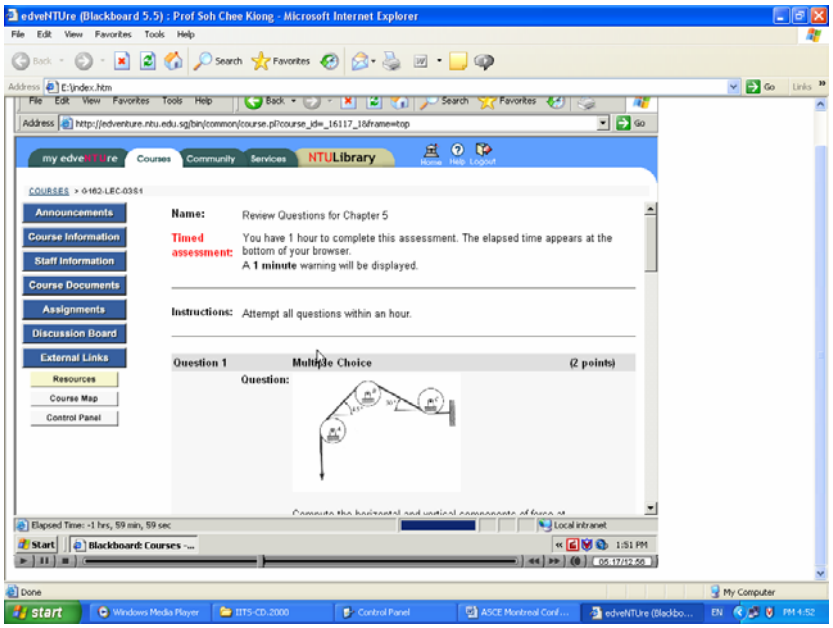

Figure 8. Example of an online quiz.

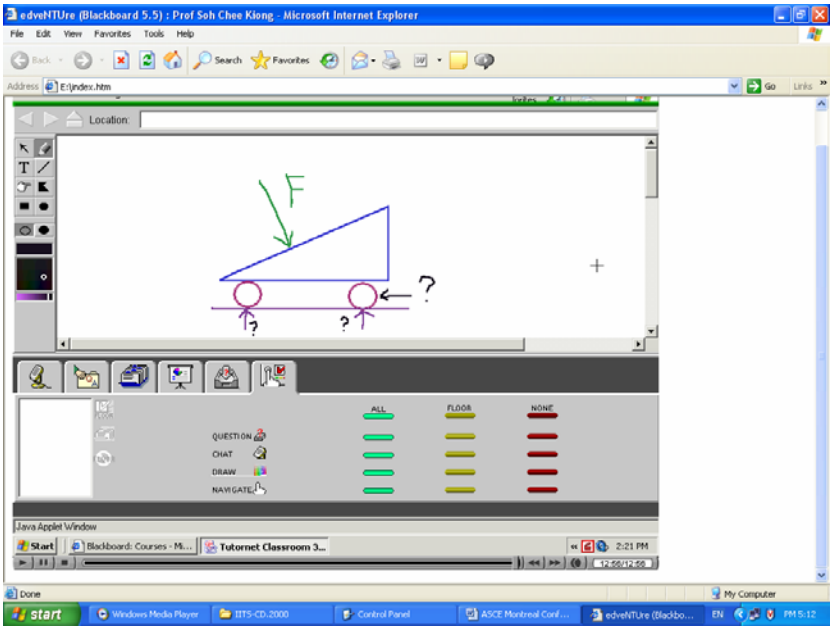

Figure9. Menu for online discussion.

CONCLUSIONS

A trial prototype version was first made available to about two-hundred first-year students who repeated the course in the second semester of academic year 1997/98. The students were asked to rate the presentation, usefulness in helping them solve the problems and learn the concepts. The student response was very encouraging. Most of the students found it very useful in helping them solve the problems. The interaction was further improved based on the

student feedback. Encouraged by the student response, the full version was implemented for the regular class of more than 1600 first-year engineering students in the first semester of academic years 1998/99 and 1999/2000. The system was installed on both the NTU Intranet and the Internet as some of the students wanted to access the system from home. IITS got tremendous response from the students of both academic years. For both years, the Internet site was accessed on an average of more than 1000 times per week. This was in addition to the Intranet usage of about 200 times per week.

At the end of the course of each academic year, the students were asked to respond to the statement: IITS helped me in learning this course. The response from both academic years of students was encouraging as about 21% strongly agreed, 41% agreed, 32% felt the system to some extent helped, while 6% disagreed. The feedback from the tutors as well as the experience of the authors was that there were far fewer questions from the students regarding the solutions of the problems. Thus, the tutors and the authors were able to use the regular tutorial sessions to explain the more difficult concepts.

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