THE JOY OF LEARNING DSP IN A LARGE CLASS

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ABSTRACT

This paper presents a new teaching method that effectively integrates IT technology into teaching and learning process. The method is well suited for teaching engineering subject in large class and contains three major components: conceptual visualizing, just-in-time teaching, and knowledge transferring. The success of the method is based on an all-in-on Educator-to-Learning portal that provides course material management, dynamic tutorial publication, intelligent tutorial diagnosis, multimedia demonstrations for visualization of difficult concepts, online simulation, virtual laboratory, and etc. The new method brings a new learning experience to students in a learner centered environment.

1. INTRODUCTION

Teaching a large class is always a very challenge task for Educators due to many difficulties imposed on the teaching-learning process. These difficulties vary from encouraging attendance, delivering well-balanced course contests to keep students' interest on subject, getting students actively participated in the learning process, and motivating students. Learning in a large class is often recognized as less effective than in a small class. With the rapid development in IT technology, especially the Internet, it is possible to address the above difficulties with the help of various existing technologies. We believe that learning in a large class is no longer less effective if innovative teaching methods are adopted and effective learning tools are provided [1-8]. The proper use of IT technology not only enhances the students learning experience but also maximizes student productivity. A successful integration of IT technology into a curriculum starts with understanding on what is a good teaching and learning practice. Ramsden [9] identifies 13 important properties of good teaching as seen from the individual lecturer's point of view. Listed below are some of these points :

- Ability to make material being taught stimulating and interesting
- A facility for engaging with students at their level of understanding

- A commitment to making it absolutely clear what has to be understood, at what level, and why
- A focus on key concepts, and students misunderstandings of them, rather than on covering the ground
- Giving the highest quality feedback on student work
- A desire to learn from students and other sources about the effects of teaching and how it might be improved.

To achieve the above, the first important step is to source technologies that will enhance students understanding and to stimulate their interest on the subject. Multimedia demonstrations and computer simulations are good candidates to achieve the goals. The second step is to establish a timely feedback loop between educator and learner. The role of feedback is any learning environment is clearly important. It provides two main functions; first, it helps educator to know what difficulties students may face in their learning process; second, it allows student to find out their weakness.

From our years of experience in teaching digital signal processing (DSP) techniques for third year students, we have identified some difficulties in teaching DSP. It is found that the DSP course is not the most attractive ones for the students, especially at the undergraduate level. This is due to the large number of mathematical equations that need in introduction of DSP concepts. However, students are fully aware the importance of DSP. The yearly increase of students in the DSP class implies the students' interests in the subject. The large class size coupled with initial difficulties gives Educator a very challenging task. Based on our observation, there are three major difficulties in addition to traditional problems we face for teaching a large DSP class. They are:

1. Entry barrier.
   To learn various DSP concepts, large numbers of mathematical equations are introduced to students at the initial stage. Students need to put some efforts to appreciate the underlying concept. It is this initial complexity and apparent abstractness that keeps

students away from learning actively. However, our observation shows that sooner or later in the course there is a moment that the students will start to grasp the larger picture once they manage to go beyond the tedious equations. The challenge posted to us is how to help the student to penetrate the barrier and speed-up this process.

2. Background divide.
A large class usually consists of students with different levels, they may vary from 2nd year to final year. The wide spectrum of students makes it very difficult for Educator to deliver well-balanced course contents to keep the attention and interest of most of students, especially there are no small group tutorials conducted for the course.

3. Broken linkage.
Although many students appear to understand the concepts and associated mathematical equations, their awareness of how and when to use the various techniques is not well developed. There is a broken linkage between gaining knowledge and applying them to solve problems.

As a direct result of the above, we have created a new teaching method that would use the power of IT to address these difficulties. This new teaching method has three major components to address the three difficulties listed above. They are conceptual visualizing, just-in-time teaching, and knowledge transferring.

The paper is organized into five sections. In Section 2, the objective of the new teaching method is introduced. The detailed components in the method and how to use these components are presented in Section 3. The assessment of effectiveness of the method is given in Section 4. The conclusion is drawn in last section.

2. OBJECTIVES OF THE NEW TEACHING METHOD

The new teaching method is designed with the following principal educational objectives.

1. To help students to penetrate the entry barrier fast so that their interest and motivation in learning DSP are well maintained and their thinking ability is stimulated.
2. To deliver well-balanced course contents in a lecture to maximize the gain of learning and to encourage active learning.
3. To enhance student's comprehension on the concepts so that transfer of learning will take place.
4. To make learning process enjoyable.

The three components in the new teaching method are supported by an Educator-to-Learner portal, *e-Learning Hub* [1,2], to achieve the above objectives.

3. DESCRIPTION OF THE METHOD

The innovative teaching method includes two essential parts : a three-step approach to address the difficulties the students have; an Educator-to-Learning portal, *e-Learning Hub*, to support three components in the innovative teaching method. In the rest of this section, we will discuss the two parts in details .

3.1 The Innovative Teaching Method

Under the new approach, the learning is conducted in three steps:

Step 1 : Conceptual visualizing. Difficult concepts and theories are introduced to students using multimedia visualization demonstrations before detailed mathematic descriptions are presented. This step helps students to overcome the entry barrier so that they are able to understand the concept quickly. This allows students to have a clear picture of the underlying concept for a mathematic description, and stimulates their curiosity and thinking ability.

Step 2 : Just-in-time teaching. The just-in-time teaching (JiTT)[3] approach has been pioneered in 1996. The basic principle behind the JiTT is to establish a timely feedback loop between the students and Educator. A carefully constructed tutorial is published on *e-Learning Hub* after each lesson to test the student's understanding on the concepts. The progress of students are captured by *e-Learning Hub* and is viewed by Educator before the next class to allow him adjusting the contents to suit the students' needs and maximize the effectiveness of learning.

Step 3 : Knowledge transferring. Virtual simulation tools and virtual laboratory are provided to students in *e-Learning Hub* to let them verify the concept and to apply the knowledge. This enhances the student's comprehension on the concept. The last step is very important for transfer of learning, it trains our students on how to apply their knowledge to solve the problem.

3.2 An Educator-to-Learning Portal -- *e-Learning Hub*

An Educator-to-Learning portal, *e-Learning Hub*, was developed for supporting each component in the innovative teaching method. Students are able to visualize the difficult concepts, conduct online simulations, and solve tutorial problems using an intelligent tutorial tool that gives student immediate diagnosis on their answers. Figure 1 shows a snap shot of *e-Learning Hub*. A detailed description of *e-Learning Hub* is given below.

Fig. 1. An Educator-to-Learner portal—*e-Learning Hub*.

Three major tools are provided in *e-Learning Hub,* they are:

1.   *Tools for conceptual visualizing*

For undergraduate students, mathematical equations are not the best way for introduction science and engineering concepts. It is always appreciated if concepts can be visualized before a mathematical description is presented. Many multimedia demonstrations are used in our DSP course to help students. They are included in the Demos in *e-Learning Hub*.

2.   Tools for Just-in-Time Teaching

The beauty of JiTT is its ability to track the students' progress. The drawback is the manpower needed for gathering the feedback from students. A web-based intelligent tutorial system is vital to the success of JiTT in a large class environment. The *e-Learning Hub* includes such a system to support JiTT[1]. The online tutorial system let the Educator to publish tutorial and generate the auto-marking scripts on the fly without knowledge of programming. The tutorial creation interface is similar to Microsoft word processor that allows Educator to pick up the tools without any additional training. It provides the

ability to automatically mark questions with four types of answer, namely, numerical answer, symbolic answer, graphic answer, and multiple choices question.

3. Tools for knowledge transferring

While a single sentence and mathematical answer is always possible for a specific tutorial question, it is highly appreciated if students can carry out a reasoned simulation before answer the question. MatLab is such a tool that is capable of such a simulation, but the learning curve involved in understanding the tool can distract a student from trying to adopt it. To encourage students to do more hands-on and cultivates students' interest in DSP, a web-based virtual simulation tool that allows student to access it from anywhere anytime is included in *e-Learning Hub* as shown in Figs.2 and 3. When the students go deeper into the DSP, the ability to develop DSP algorithms becomes important for them. A web-based virtual laboratory was developed for this purpose that trains the students in developing DSP algorithms as shown in Fig.4.
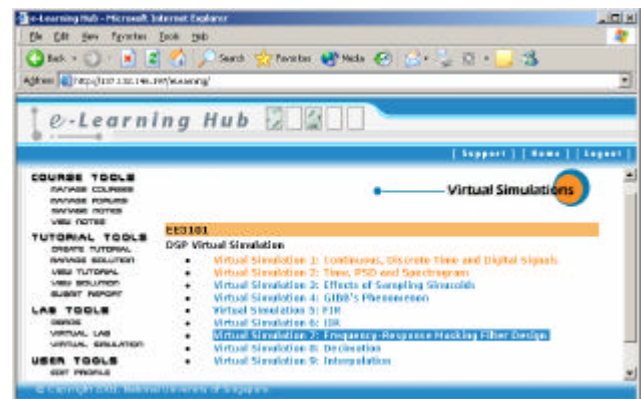

Fig. 2 Virtual simulation tools.

4.   ASSESSMENT OF EFFECTIVENESS

In assessing the effectiveness of the innovative teaching method and its supporting tools, we use two measurements, the students' performance and their feedback. Under the new approach, our observation shows that the students need less time to develop a full comprehension of the difficult concepts, and their performance have been improved significantly. The following are some feedback from students.

1.   *"Creative in teaching."*
2.   *"Clear explanations of concepts. Interesting lessons."*
3.   *"Enjoy attending the lectures."*

4. *"Good Lecturer ! Not boring and teaches well enough to be understood."*
5. *"Great Lecturer ! Explains well and lectures are interesting."*
6. *"Adopts the technology well in the lessons to make concepts easier to grasp."*
7. *"Uses multimedia to help understanding. Very outstanding."*
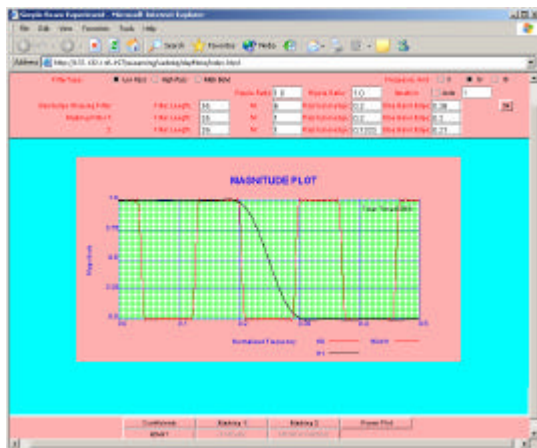8. *"Very effective use of multimedia visual aids."*

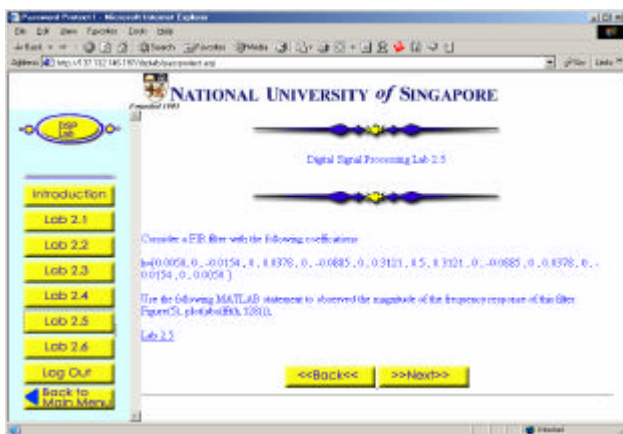**Fig. 3 A virtual simulation tool for filter design.**

Fig.4 Virtual Lab.

9. *"Online tutorial allows students to do tutorials and spot mistakes in solutions immediately. Ability to bring ideas and concepts across clearly."*
10. *"The lecture has focused on the important parts, and very attractive."*
11. *"Ability to stimulate student thinking."*

6. CONCLUSION

A new teaching method for teaching large class effectively are presented. The method includes three major components to address the difficulties faced by students in learning an engineering course. It is based on a successful integration of IT technology with the curriculum. The feedback from the students is very positive and encouraging. The students' performance is improved significantly.

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