

TEACHING DSP EFFECTIVELY IN A LARGE CLASS USING INSTANT FEEDBACK

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ABSTRACT

This paper presents a new teaching method that effectively integrates IT technology into teaching and learning process. The method enhances the learning of digital signal processing fundamentals in a large class. It contains three major components: conceptual visualizing, instant feedback, and knowledge transferring. The success of the method is based on an all-in-one Educator-to-Learner portal, *e-Learning Hub*[1], that provides course material management, dynamic tutorial publication, intelligent tutorial diagnosis, instant feedback, 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 contents 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 used 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 :

1. Ability to make material being taught stimulating and interesting
2. A facility for engaging with students at their level of understanding
3. A commitment to making it absolutely clear what has to be understood, at what level, and why
4. A focus on key concepts, and students misunderstandings of them, rather than on covering the ground
5. Giving the highest quality feedback on student work
6. A desire to learn from students and other sources about the effects of teaching and how it might be improved.

From our years of experience in teaching DSP, we found that it is quite difficult to fulfill them in a large class of 200 or more students using the traditional teaching method. The wide spread of students' background makes the educator very difficult to deliver right amount of information to the students such that most of students' interests in the subject are maintained. On the other hand, it is possible to incorporate them to a large class if we integrate the IT technology into our teaching. In this paper, we present a new teaching method that is very effective in teaching a large class. The method integrates various IT technologies into a learning portal including multimedia, virtual laboratory, automatic tutorial grading system, and instant feedback system. The new method brings a new learning experience to students in a learner centered environment.

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

2. THE NEW TEACHING METHOD

To develop a new teaching method, it is important to understand the difficulties faced by the students in a large class. We have identified some of them in our DSP course for third and final year students. It is found that the DSP course is not the most attractive course for the students. This is due to the large number of mathematical equations that are needed in introduction of DSP concepts. But we noticed that the number of students attending the class increases every year. This is because the students are fully aware the importance of DSP, and the course serves as pre-requisition for many high level courses. Many students are forced to take the course. The large class size coupled with low interest 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, instant feedback, and knowledge transferring.

The conceptual visualizing uses multimedia visualization demonstrations to visualize the difficult concepts and theories to the students before detailed mathematic descriptions are presented. This helps students to overcome the entry barrier so that they are able to understand the concept quickly and allows students to have a clear picture of the underlying concept for a mathematic description, and stimulates their curiosity and thinking ability. Our observation shows that the students' interests in the subject are successfully maintained after the introduction of the new method. Many students start to explore the contents beyond the requirements of the course.

The instant feedback aims to create a timely feedback loop between educator and learners. The role of feedback in 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. With this information, the educators will be in a good position to help the students to overcome their difficulties. Second, it allows student to find out their weakness, so the student is engaged in the learning process. We used two types of feedback to gather the information on the students' progress. The in-class feedback is achieved by using SMS messaging service. With the increasing population of the mobile phone, we found that more than half of the students bring mobile phone to the class. The SMS messaging service provided by mobile phone offers an excellent way to establish an in-class instant feedback mechanism. We have developed a SMS-based quiz system to facilitate such a feedback mechanism. The system allows the educator to prepare several sets of in-class quiz using a web-based quiz creation system before each lecture. After the introduction of the new concepts during the lecture, the educator can conduct the in-class quiz by publish one of the created quizzes and the students will send their answers to the feedback system using their mobile phone. The feedback system collects all answers from the students and generates a statistic bar-chart immediately. From the statistics, the educator knows the difficulties faced by the students and will be able to adjust the course contents according to suit the students' need and maximize the effectiveness of learning.

Such an instant feedback system has three advantages: first, the educator is able to teach according students' need. Often times we teach a course based on our experience and use previous batches of students as reference. It gives us a rough idea on students' learning pattern. But each batch of the students may learn differently. We found that the students from computer engineering learn quite different from the electrical engineering students, so as the junior and senior students.

The mixtures of different types of students vary from semester to semester. Sometimes our experience may not work well. The instant feedback system let us know exactly what happens among the students, so we can address their problems instantaneously. Second, the students know their problems immediately. It is quite often that the students seem to understand the new concept, but they are at lost when ask them to apply it. The in-class quiz helps the students to identify their problems and weakness, so that they will be engaged in the learning and become an active learner. Third, the system acts as a tracking mechanism to monitor the students' performance. Each time the student responses to a quiz, the system keeps a record. At the end of quiz, the system generates a report on each student. The report includes the performance of the student from the beginning of the class. The educator can set a threshold to allow the system to alert the educator on weak students.

The instant feedback system is able to publish two types of quiz, multiple choices question and the question with numeric answers. It is designed in such a way that the students without the mobile phone are not left out. The input to the quiz contains three fields, a course code, answers to questions, and an optional user login name. If a student uses a mobile phone other than the one registered, (s)he will need to enter the user login name in the third field. At the beginning of the class, each student requires to create an account at the Educator-to-Learner portal, *e-Learning Hub* [1] that includes the instant feedback system. The student is required to register their mobile phone number if (s)he has one. When the student enters his/her answers, the system will automatically identify the student and keep a record of his/her answer. For the student without a mobile phone, there are two alternatives, (s)he can borrow a mobile phone from others in the class or make use of the Educator-to-Learner portal to enter the answers after the class.

Besides the in-class feedback, there is a web-based tutorial system. This web-based tutorial system is built with certain level of intelligence. It lets 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. 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 is 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. The online tutorial

system together with the instant feedback system serves as an effective feedback loop between the learner and the education. The beauty of such a system is its ability to track the students' progress and makes the learning in a large class more efficient than the traditional teaching method. Figure 1 shows one of the screens of the *e-Learning Hub*.

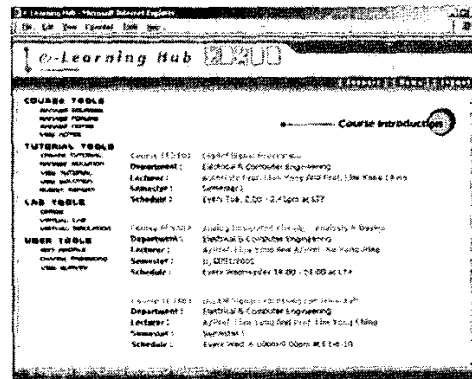


Fig. 1. An Educator-to-Learner portal—*e-Learning Hub*.

Knowledge transferring system is developed with the goal to help the students to build the linkage between gaining knowledge and applying them. 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 they have learnt in the class. This enhances the student's comprehension on the concept and is very important for transfer of learning, it trains our students on how to apply their knowledge to solve the problem.

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 Fig.2. 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.

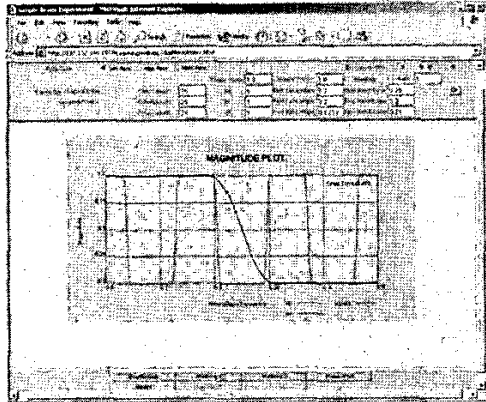


Fig. 2 A virtual simulation tool for filter design.

3. ASSESSMENT OF EFFECTIVENESS

In assessing the effectiveness of the new 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. "Clear explanations of concepts. Interesting lessons."
2. "Adopts the technology well in the lessons to make concepts easier to grasp."
3. "Uses multimedia to help understanding. Very outstanding."
4. "Very effective use of multimedia visual aids."
5. "Online tutorial allows students to do tutorials and spot mistakes in solutions immediately. Ability to bring ideas and concepts across clearly."
6. "The lecture has focused on the important parts, and very attractive."
7. "Ability to stimulate student thinking."

4 CONCLUSION

A new teaching method for teaching large class effectively has been presented. The method includes three major components to address the difficulties faced by students in learning DSP. 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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