An Integrated e-Learning Platform for Learning-by-Doing in Large Classes

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Abstract *— There are many difficulties in t eaching large classes. This paper presents an e-Learning platform, e -Learning Hub, to promote learning -by-doing in large classes. The proposed e -Learning Hub is based on experiential learning theory and integrates doing int o every step of learning process . It combines various teaching and learning stra tegies in a single platform to suit the needs of students with different learning styles in a large class . The combined strategy allows e-Learning Hub to achieve the following educational objectives. 1. To enhance student comprehension on the concepts so that their thinking ability is enhanced. 2. To stimulate deep thinking and enhance student's capabilities of transferring what they have learnt to new situations so that transfer of learning takes place. 3. To develop and foster independence of learning in which student develops the ability to discover and reconstru ct knowledge for themselves. The e-Learning Hub creates a learner-centered environment and makes learning more effective, efficient, meaningful, and joyful in a large class.*

Index Terms *— Teaching large class es, active learning, learning by doing, experiential learning , Internet based learning, e-Learning.*

INTRODUCTION

With the increased enrolment and shrank budget in colleages and universities, teaching large classes in higher education becomes unavoidable. It is a very different experience in teaching a large class compared to a small one. The difficulties encountered in large classes include [1]: engaging students in active learning, personalizing the environment, working with diverse student needs and backgrounds, managing classroom disruptions, adapting one's teaching style to the large lecture situation, etc. How do we overvome these difficulties and enhance the learning experience in a large class? One possible solution is to leverage on the vast experience accumulated in teaching small classes. In order to do so, we need to identify the differences between large and small classes and try to create a small-class environment in a large one so as to achieve the same quality as in a small class. It is generally accepted that learning outcomes are inversely proportional to class size, i.e. the smaller the class is, the better the student learns. However recent foundings revealed that class size does not necessarily correlate to learning outcomes and student satisfaction. The size of a class is not the most important factor affecting the learning outcomes, rather the teaching quality plays an important role in the learning process. The key to the success is the student's participation in the learning process. The main advantage small classes has over large ones is that they provide students with more opportunities for interaction, feedback and more personalized environment, which leads to higher teaching quality and greater student satisfaction [2]. The question is how to duplicate the small class environment in a large one without incurring additional manpower cost. Many researchers [3]-[8] proposed different ways to address these issues. We believe that the better teaching quality can be achieved by applying a learning-by-doing strategy in a large class. Such a strategy is well suited for teaching engineering students as skill development is one of the important components in engineering education.

There are many articles available with the keywords of teaching large classes and learning-by-doing, but few articles can be found with keywords of the marriage of the both teaching large classes and learning-by-doing, or articles about integration of learning-by-doing in teaching large classes. This paper will give the instance of the integration of learning-by-doing into large class with the help of an Eductor-to-Learner Portal, *e-Learning Hub* .

We begin this paper with a brief introduction of the Kolb's theory of experiential learning and the motivitaions of introduction learning-by-doing into large classes. Followed by the detail description of *e-Learning Hub* . We use one of courses on digital signal processing to illustrate how to promote learning-by-doing in a class with about 300 students.

MOVITATIONS TO INTRODUCE LEARNING-BY-DOING IN A LARGE CLASS

David Kolb introduced a well known theory about experiential learning in 1984 [9] which stated that "Learning is the process whereby knowledge is created through the transformation of experience." The theory presents a way of structuring and sequencing the curriculum and indicates, in particular, how a session or a whole course may be taught to improve students' learning [10]. According to the theory there is a learning cycle which includes a four-stage model showing how experience is translated through reflection into concepts, which in turn are used as guides for active experimentation and the choice of new experiences. Kolb refers to these four stages as: concrete experience (feeling), reflective observation (watching), abstract conceptualization (thinking) and active experimentation (doing). They follow each other in a cycle as shown in Figure 1. Besides, there are two primary axes that lie behind the cycle: an "abstract-concrete" dimension that relates to how we think about thing, and an "active-reflective" dimension that is about how we do things.

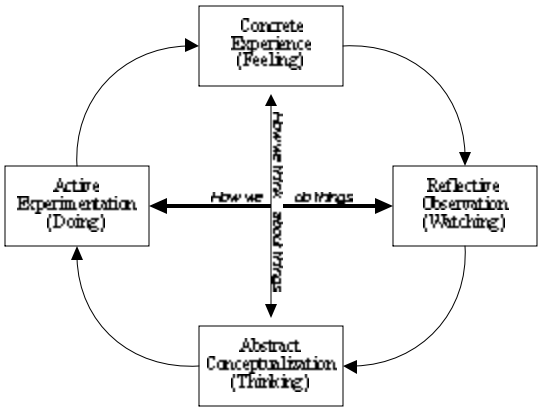

FIGURE 1
LEARNING CYCLE

The experiential learning occurs as a direct result of the learner's participation in events, it utilizes the participants' own experience and their own reflection about that experience [11]. The effectiveness of such an approach is based on the premise that students learn best from doing something. It is well said that there is really only one way to learn how to do something that is to do it [12]. There are still many studies and literature show that students learn better when they are physically engaged in the learning process. The best way to engage students is to adopt a learning-by-doing strategy, i.e. let them do something, trying something, watching how well or poorly it works, reflecting on how to do it differently, then trying it again and seeing if it works better [13].

A large class usually consists of a wide spectrum of student. With the increased diversity in the student population, not only in race and culture, but also in age and knowledge background, it is important to address the different learning styles and comprehension abilities. The needs of all learners are best met through the use of a variety of activities that best match their preferred learning styles. According to Kolb's theory, learning is enhanced as more of the learning stages are used. It is better to provide all the four learning styles, active, reflective, abstract and concrete, so that all students in the class can use their preferred styles to study. The learning-by-doing provides various learning activities to cater for different learning styles by spending time to teach each of the different learning styles through the learning cycles and encourage students to adopt to different learning styles. By providing preferred learning styles for every student learning-by-dong realizes personalized environment in larger classes as in smaller classes. Such an approach provides a learner-centered environment for students and promotes active learning in a large class.

LEARNING-BY-DOING IN ACTION

To facilitate learning-by-doing in a large class, we need to provide students with learning-by-doing activities within a classroom and between each lesson. In-class activities, such as buzz group and think-pair-share [14]-[15], invite students to participate actively in the learning process. Tutorials, assignments and laboratory sessions are some of the after-class activities that fill the gap between two lessons. These activities should be made available to students anytime and be accessed from anywhere. Internet is such an enabling platform that gives access to students from anytime and anywhere. To support learning-by-doing for the course, Digital Signal Processing (DSP), we developed an Educator-to-Learner Portal, *e-Learning Hub* , that integrates doing into every step of learning process. *e-Learning Hub* provides students with a learner

centered environment to facilitate the learning. It includes: online multimedia learning materials, simulation tools, multimedia demonstrations to visualize difficult concepts, virtual laboratory tools, online intelligent tutorial tools, and quiz system with real-time feedback. These tools match students with their preferred learning styles, expose them to other learning styles, and systematically guide them through Kolb's learning cycle.

The students are provided with four sets of tools under *e-Learning Hub* as shown in Figure 2, including Course Tools, Tutorial Tools, Hand-on Tools, and User Tools. The course and user tools are for students to manage their courses and user account. The tutorial and hands-on tools are mainly for learning-by-doing activities. In the following sections, we give the detail descriptions of these two learning tools under *e-Learning Hub* and how we can use them to achieve the goal of learning-by-doing.

FIGURE 2
INTERFACE OF *E_LEARNING HUB*

Tutorial tools

1. SMS tutorial system with instant feedback

The diverse background of students in a large classroom calls for an adaptive approach to suit different learning styles among students. It is very hard to determine what teaching method should be used for a given topic if we do not know what difficulties are faced by students. One of the advantages of smaller classes has over the larger ones is that it provides more opportunities to get feedback from students. *e-Learning Hub* addresses this problem by reinforcing the interaction between students and the lecturers and provides instant feedback by using SMS based instant feedback system. The instant feedback is achieved by using Short Message Service (SMS) provided by mobile phone. The selection of SMS service as an instant feedback tool has two advantages [16]. Firstly, it is most cost effective way to gather instant feedback and is easily to integrate with a web-based system. Secondly, it is an effective method to grasp students' interest and attention and engage them in the learning process. Students are very familiar with SMS service. They are very excited when such a service is applied to learning. The SMS instant feedback system is designed for all students. To implement it in a large class, many small discussion groups of 2 – 4 students are formed at the beginning of the course with each group having at least one mobile phone. A think-pair-share approach is adopted when an in-class quiz is conducted. The students work on the quiz individually and then pair up to compare and improve their answers before they submit a final one to SMS system. In such a way, the system does not leave out the students without a mobile phone. Such think-pair-share approach not only allows students to share handphone but also promotes the cooperative learning.

The SMS based quiz feedback system is able to diagnose students' input automatically and provide real-time feedback to students and lecturers. Figures 3 and 4 show the one example of SMS quiz and the statistic bar chart viewable by the lecturer, respectively. During a lesson, the lecturer will give students a quiz whenever there is a need to check students' understand on a given topic. Students will answer the quiz by sending a SMS message to an instant feedback system. The instant feedback system will automatically grade students' answers and give feedback to both students and the lecturer. For students, if the answer is right, system will give "Congratulation" message, while for the wrong answer SMS feedback system provides subject-related hints or advices to encourage students to continue their effort in finding correct answer which promotes students participation in learning. For the lecturer, SMS feedback system provides a statistic bar chart of the answers from all

students, which helps the lecturer to identify the weak points of the students and to adjust the teaching content, pace or strategies accordingly.

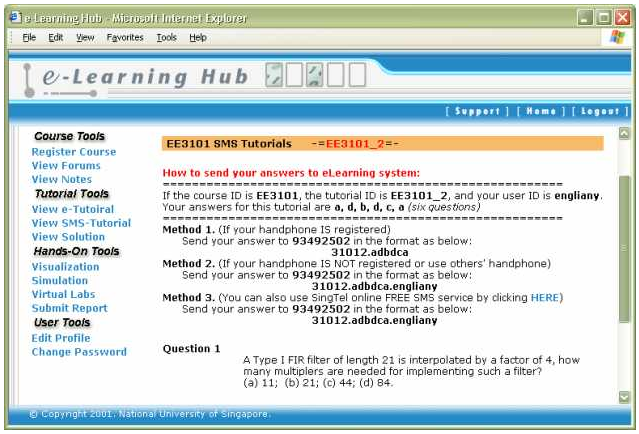

FIGURE 3
AN EXAMPLE FOF SMS TUTORIAL

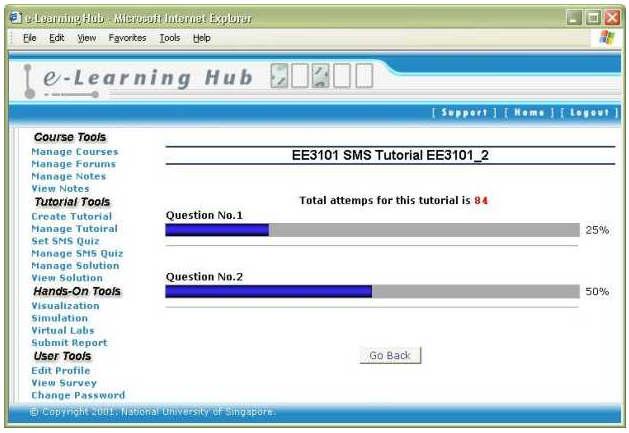

FIGURE 4
FEEDBACK FROM SMS TUTORIAL

Hands-on tools

1. Visualization tools

One of the difficulties in learning DSP is large numbers of mathematical equations 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 of the subject that keeps students away from learning DSP. However, the students start to appreciate the DSP techniques once they manage to go beyond the tedious equations. The challenge posted to us is how to help the students to penetrate the initial difficulties fast so that their interest in DSP is well maintained. *e-Learning hub* incorporates a set of multimedia demonstrations to visualize the concepts before mathematical descriptions are presented. This helps student to understand the concept quickly. It gives student a clear picture of the underlying concept for a mathematic description, and stimulates their curiosity and thinking ability. The students are given access to the demonstrations and are able to view them at anytime from anywhere. These demonstrations give students intuitive experience and comprehension of related theory or algorithms. Active student participation is a key to concept, principle or skill learning. Demonstrations maximize the participation of students. Our experience shows that students display a very high level of interests towards these demonstrations because they are dealing with something concrete which they can experience first hand. Besides, multimedia demonstrations give students practical experience to "observe and reflect" on what they have just witnessed. This process is one type of doing and helps

students to improve their comprehension on difficult concepts during the watching process. Figure 5 shows a multimedia demonstration of the relation between the frequency response and *z*-transform transfer function of an FIR digital filter.

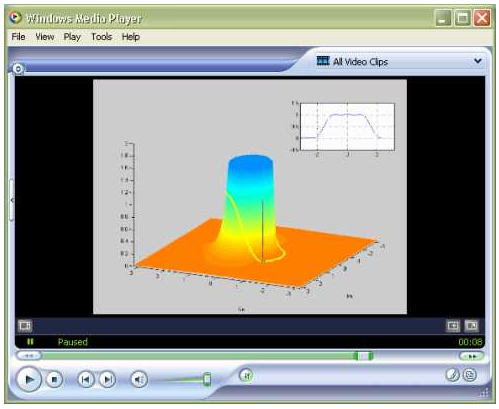

FIGURE 5
AN EXAMPLE OF MULTIMEDIA DEMONSTRATION

2. Simulation tools

Simulations offer a fun and effective way to enable students to learn by doing and provide opportunities for active experimentation in solving practical problems which requires the application of knowledge learnt. Simulation models a real or theoretical system through which students are allowed to manipulate input variables and observe the consequences, to formulate and test hypotheses, to interpret principles or properties displayed by models; The most importance is that simulations provide a controlled environment which affords the individual an opportunity to learn by making mistakes, correcting errors and receive additional information in the form of instructive feedback. In the course of DSP, a single sentence and mathematical answer are always possible for a specific tutorial question. It is highly appreciated if student 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 tools can distract a student from trying to adopt it. *e-Learning hub* provides many simulations to help students to assimilate abstract ideas, concepts and principles, such as to illustrates the relationship between continuous-time and digital signals, to show the effects of sampling an analog signal, to design a frequency response masking filter, and to examine the effect of interpolation. Fogure 6 shows the user interface of visual simulation that provides an interactive interface to give students opportunity to operate the simulations.

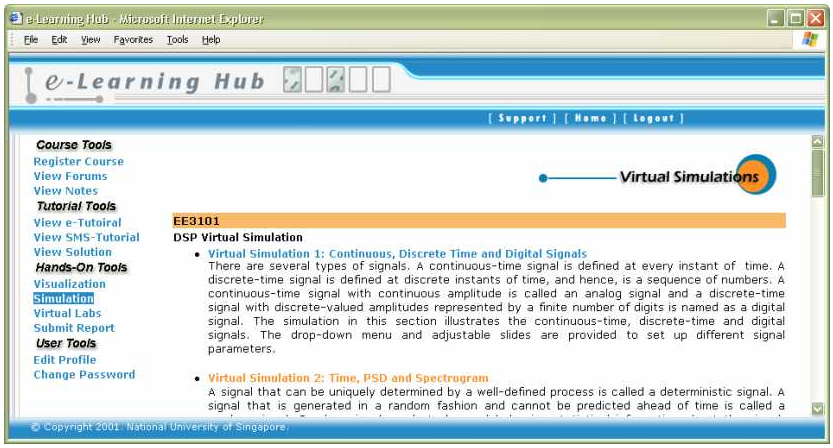

FIGURE 6
VISUAL SIMULATION USER INTERFACE

3. Virtual laboratory

Virtual Laboratory offers another way to motivate students to conduct experiments using a web browser, affords more individualized and independent learning, provides simulations of complex processes that are similar to a real laboratory. Virtual laboratory is particularly useful for large classes as it is not limited by lab space. Students are able to access it anywhere and anytime.

Virtual laboratory experiences can reinforce concepts from lecture material, convey practical issues associated with actual experiments, and urge students learn through observation and critical thinking thus encourage student to learn by doing. Under the Kolb's model of learning styles, students' concrete experience and reflective observation are enhanced from the repeatability of the experiments. For the DSP course, the ability to develop DSP algorithms becomes important for students when they go deeper into the DSP. A virtual laboratory becomes a good starting point for them to develop such skills. It shortens the learning curve of programming lauguage by guiding student step by step in writing simple DSP algorithms. Figures 7 shows the visual lab user interface for a guided lab.

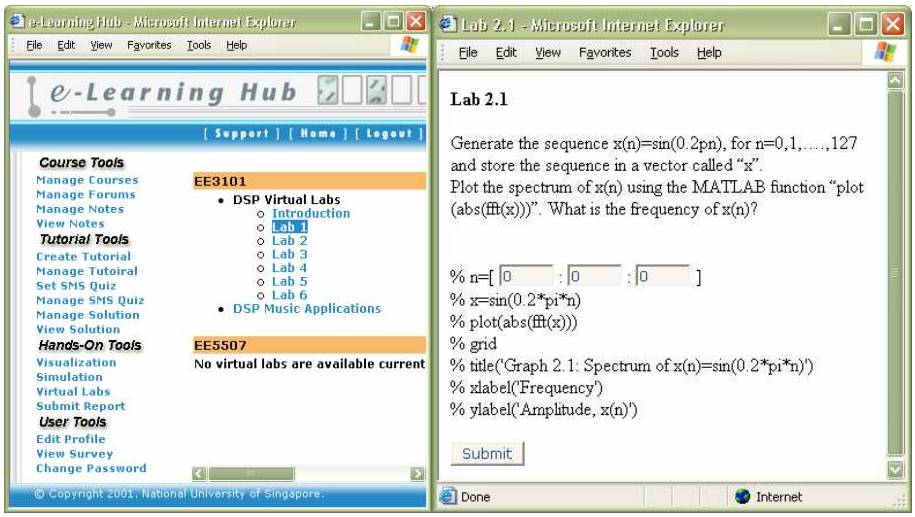

FIGURE 7
AN EXAMPLE OF VIRTUAL LAB

CONCLUSION

We have presented an Educator-to-Learning Portal, *e-Learning Hub*, that supports learning-by-doing in large classes. The success of *e-Learning Hub* is the integration of learning by doing in every step of learning process based on Kolb's theory of experiential learning. It guides students through four stages in the learning cycles, provides different tools to suit students' preferred learning styles, encourages them to participate in different learning activities, and provides personalized learning environment in a large class. *e-Learning Hub* facilitates learning by doing in a learner-centered environment and makes learning more effective, efficient, meaningful, and joyful in a large class.

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REFERENCES

[1] Large Classes: A Teaching Guide Large Class Introduction, http://www.cte.umd.edu/library/large/intro.html.

[2] Teaching Large Classes at UCSB, http://www.oic.id.ucsb.edu/Resources/Teaching/Large.ucsb.html.

[3] Gibbs G., and Jenkins A, "Teaching Large Classes in Higher Education, London," Kegan Paul, 1992.

[4] Carbone E, "Teaching Large Classes: Tools and Strategies", SAGE Publications, 1998.

[5] Lian Y., and Tan Y.H., "An Educator-to-Learner Portal for Just-in-Time Teaching," *Proceedings of the Second Symposium on Teaching and Learning in Higher Education* , 2002, 420-425.

[6] Lian Y. , "Learning Digital Signal Processing at Six Degrees of Freedom," *Proceedings of the Second Symposium on Teaching and Learning in Higher Education* , 2002, 444-449.

[7] Lian Y., "Teaching large Class Effectively with the Help of IT," *Proceedings of 2002 International Seminar on Information and Communication technologies* , 2002,225-230.

[8] Lian Y., "The Joy of Learning DSP in a Large Class," *Proceeding s of 2003 IEEE International Conference on Acoustics, Speech, and Signal Processing* , 2003, 753-756.

[9] Kolb, D.A., "Experiential learning: experience as the source of learning and development," Englewood Cliffs, New Jersey: Prentice-Hall, 1984.

[10] Healey, M. & Jenkins, A. (2000) Kolb's Experiential Learning Theory and Its Application in Geography in Higher Education, *Journal of Geography* , 1999, pp.185-195.

[11] http://www.cs.tcd.ie/crite/lpr/teaching/kolb.html.

[12] Learning by Doing, http://www.engines4ed.org/hyperbook/nodes/NODE-120-pg.html.

[13] R.M. Felder and R. Brent, "Learning by Doing," *Chem. Engr. Education* , 37(4), 2003, 282-283.

[14] Small group teaching: A short reading list, http://www.adm.uwaterloo.ca/infotrac/liblst4.html#using

[15] Lochhead J. and Whimbey A., "Teaching analytical reasoning through thinking aloud pair problem solving," *Developi ng Critical Thinking and Problem -Solving Abilities,* New Directions for Teaching and Learning, No. 30, San Francisco, Jossey-Bass, 1987.

[16] Lian Y., "Teaching Large Class Effectively Using Adaptive Technique," Innovations 2004: World Innovations in Engineering Education and Research, INEER, 2004.