Work In Progress: Using Tablet PCs to Integrate Lecture and Laboratory in an Introductory Electrical and Computer Engineering Course

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***Abstract* - In the Spring of 2006, Tablet PCs were used in a new introductory course in Electrical and Computer Engineering to bridge the gap between lecture and laboratory activities. Additionally, the Tablet PCs facilitated active learning in the classroom, such as by wirelessly recording feedback on concept questions and enabling collaborative problem solving. These activities allowed lecture content and pacing to be dynamically modified to address students' questions, misconceptions, and interests. Students also ran interactive simulations either before or after laboratories on their Tablet PCs, making classroom demonstrations more engaging while encouraging the development of ideas to test in the laboratory. The same Tablet PCs were carried to the laboratories, where students used them to run simulations, collect data, and record observations that were shared in class. Student engagement was very high and students overwhelmingly indicated that the Tablet PCs enhanced the learning experience in both the classroom and the laboratory.**

Index Terms – active learning, student engagement, Tablet PCs, technology enhanced classroom.

INTRODUCTION

The Department of Electrical and Computer Engineering (ECE) at Duke University has recently redesigned its undergraduate curriculum. The goals of the redesign include an increased emphasis on real applications and design, more comprehensive use of computational tools, and an increased integration of lecture and laboratory instruction. These goals have been achieved, in part, through the use of innovative pedagogical tools and techniques, such as the use of Tablet PCs to facilitate more active learning.

The newly-developed cornerstone course, *Fundamentals of Electrical and Computer Engineering*, has been designed with these curricular goals in mind. This course provides first-year students with a rigorous introduction to core areas of ECE, so that students gain an understanding of the breadth and depth of the discipline. Concepts are taught using a just-in-time approach: a topic is presented in lecture when it is necessary for the next step of the students' laboratory project. Although this methodology could be implemented without mobile technology, it would be challenging at best to ensure adequate integration. Tablet PCs offer one way to bridge the gap between lectures and laboratories, both physically and intellectually, in order to link abstract concepts presented in lecture with hands-on applications pursued in the laboratory.

USE OF TABLET PCS IN THE CLASSROOM

In the pilot offering of *Fundamentals of ECE* in the Spring of 2006, Tablet PC technology was used in a variety of ways in the classroom to increase student engagement. One use of Tablet PCs was in a modified Think-Pair-Share activity in which students considered a question and shared their opinion by submitting their response to the instructor using Classroom Presenter software [1, 2]. This type of activity served as a discussion catalyst and enabled students (even quiet ones) to express, defend, and question each other on a variety of topics.

Tablet PCs were also used to present computational and conceptual questions to students. In these activities, students had the opportunity to apply newly-learned concepts to solve a variety of problems. After submitting their solutions to the instructor using Classroom Presenter, a quick review often revealed common misconceptions. By strategically selecting several submissions for public review, the instructor was able to guide the students toward the discovery of the common misconception and its root (see Figure 1, for example). Such activities not only engaged students, but also served as a means for the instructor to gauge student understanding.

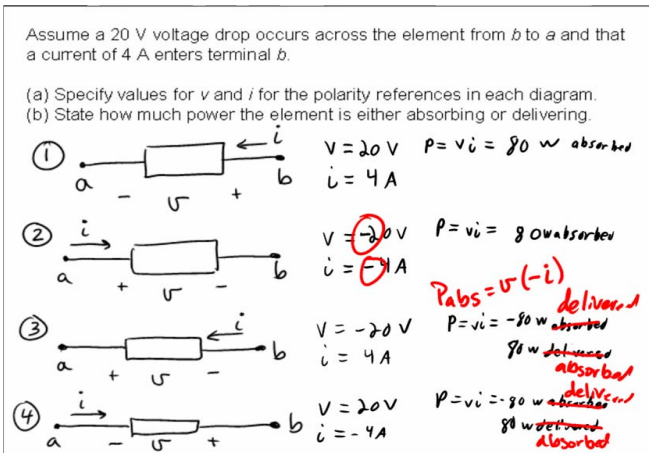

FIGURE 1
IN-CLASS PROBLEM SOLVING EXAMPLE: ACTUAL STUDENT SLIDE SELECTED FOR GENERAL DISCUSSION AND MARKED BY INSTRUCTOR.

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Tablet PCs were also used to periodically collect student feedback via minute papers on a variety of topics, the results of which were then used in preparation for the following lecture.

USE OF TABLET PCS IN THE LABORATORY

In the laboratory, Tablet PCs were integrated into the projects and used to maintain comprehensive laboratory notebooks (see sample excerpt in Figure 2). Students also ran simulations either before or after laboratories on their Tablet PCs, making classroom demonstrations more engaging while encouraging the development of ideas to test in the laboratory. Because Tablet PCs were used in both the laboratory and the classroom, students had all notes and data available to them at all times, improving the integration of the two course components. This changed course instruction by enabling the instructor to more easily integrate laboratory activities into classroom discussions. Doing so motivated students to understand lecture topics since they could see immediate application of the material in the laboratory projects.

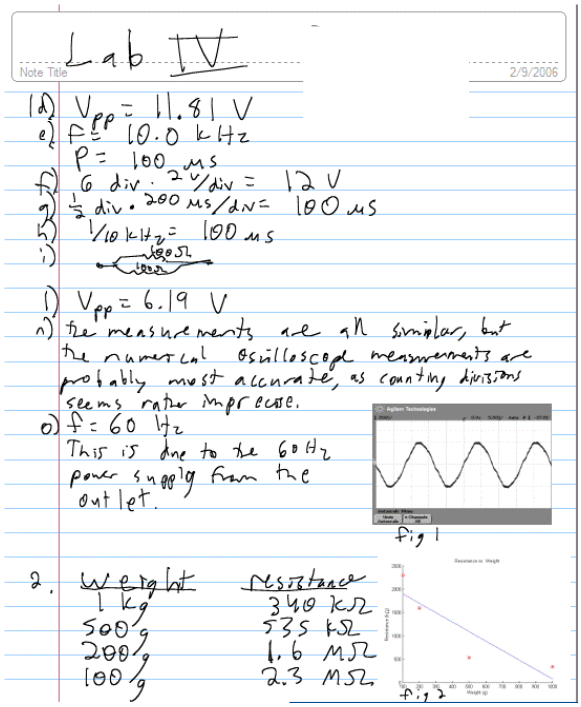

FIGURE 2
PAGE FROM STUDENT LABORATORY MANUAL ILLUSTRATING INCORPORATION OF DATA RECORDINGS AND PLOTTING OF DATA.

ASSESSMENT

At the end of the semester, students were surveyed to assess some of the benefits and limitations of the Tablet PCs. Of the nineteen students in the course, twelve students responded to the survey (N = 12), yielding a 63% response rate. The top five uses of the Tablet PCs included: 1) participation in classroom activities (100%), 2) as a comprehensive laboratory notebook (100%), 3) as an integral part of laboratory projects and experiments (92%), 4) to run MATLAB or other simulation software (75%), and 5) to take notes during lecture (75%). Students were asked to rank the usefulness of the Tablet PCs for each of these activities. Interestingly, no one activity was ranked as the most or least useful by a majority (see Figure 3). Rather, it seems that each student benefited in potentially different ways, a possible reflection of different learning styles.

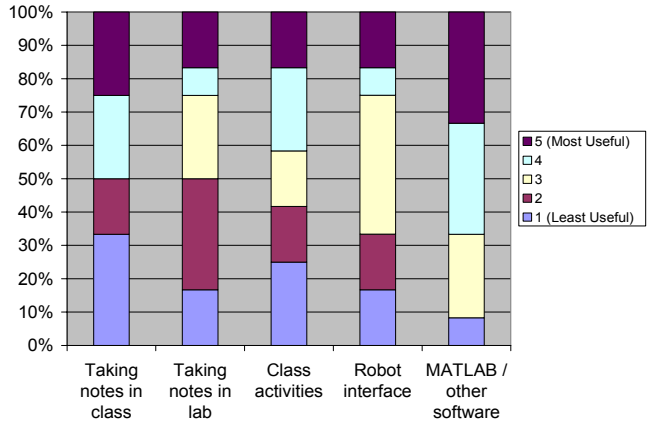

FIGURE 3
STUDENT EVALUATION OF TABLET PC USEFULNESS (N = 12)

Students overwhelmingly indicated that the Tablet PCs enhanced the learning experience in the classroom (92%) and unanimously agreed that the Tablet PCs enhanced the laboratory learning experience. However, the class was evenly divided regarding whether the Tablet PCs facilitated the integration of the lecture and laboratory components of the course. Ultimately, 92% of the students recommended that Tablet PCs be adopted in other ECE courses.

CONCLUSIONS

Overall, the Tablet PCs significantly impacted the delivery of course material and the students' learning experience. Student engagement was very high, in part, because the Tablet PC-based activities demanded the students' attention and improved their conceptual understanding. These activities also enabled the instructor to dynamically modify the lecture to address student misconceptions and to more easily incorporate laboratory activities into classroom discussions, thereby narrowing the traditional gap between the two.

ACKNOWLEDGMENT

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REFERENCES

[1] Classroom Presenter application software, http://www.cs.washington.edu/education/dl/presenter, (current May 2006).

[2] Anderson, R., Anderson, R., McDowell, L., and Simon, B. "Use of Classroom Presenter in Engineering Courses", in *Proc. Frontiers in Education*, 2005.