

**AC 2007-2060: REDEFINING “DISTANCE” EDUCATION: INCREASING DIVERSITY, ACCESSIBILITY, AND/OR CLASSROOM PARTICIPATION IN ENGINEERING COURSES ON A TIME, FINANCIAL AND TECHNOLOGY SHOESTRING**

**Thomas Walker, Virginia Tech**

Associate Professor of Engineering Education at VPI & SU. He earned his BSEE degree from Purdue University and his MSME from the Naval Postgraduate School. His primary academic and pedagogical interests are in the areas of distance/asynchronous learning technologies and methods, object-oriented programming, and object-oriented modeling. He is a licensed Professional Engineer.

# **Redefining “Distance” Education: Increasing Diversity, Accessibility, and/or Classroom Participation in Engineering Courses on a Time, Financial, and Technology Shoestring**

## **Abstract**

This paper presents four semesters of methodology and results, some expected, some unexpected, from using Tablet PC technology and appropriate software tools to teach an introductory problem solving programming course for second-year engineering majors. The methods used provide both real and virtual seats in the same course with real student asynchronous world-wide participation at very minimal personal, personnel, technology, and time costs for both students and instructors. The results are overwhelmingly positive and the methods can be applied to all or parts of multiple courses and curricula. There is definite applicability to K-12 outreach programs as well as community/junior college collaborative programs. Issues addressed include learning styles, under-represented minority participation, student peer support and collaboration, student classroom participation, budgetary and personnel resources, computer grading, and course management systems. Methods and technologies involved will be used and demonstrated during the presentation.

## **Background**

The concept of “distance” or “online” courses is not only generally accepted by most engineering schools, appropriately and properly developed courses are demanded by students, administrators, and, in the case of publicly-funded institutions, state governments. Until very recently, courses were simply divided into two specific categories, “online/distance” or “in-class/traditional”, based solely on the method (or place) of delivery/receipt which was either over the “web” or in the classroom. The widespread availability of web-based “course management systems” (CMS) in the late 1990s provided a catalyst for foundational changes in course delivery. As CMS capabilities continue to expand and improve they have been adopted by faculty and students as an integral part of the undergraduate academic experience. Progressive instructors understand that “...CMS enables teachers to extend the classroom beyond its traditional boundaries of time and space.”<sup>1</sup> Of course, instructors might also take the time to replace “CMS” with “textbooks” and reread that sentence. The question is not one of “extending the classroom” with technology – it is one of changing the teaching/learning paradigm with technology in a way that enhances “learning” without requiring significant additional financial, temporal, or physical resources. Coincidentally, driven largely by a combination of decreasing resources and increasing demand, engineering instructors are being “encouraged” to develop “online” versions of their courses. The two greatest disincentives to offering engineering courses in “distance” mode are the additional effort required for faculty to prepare and deliver the materials and the concurrent loss of the immediate feedback the instructor receives in a typical “small” classroom environment. An “online” offering of a course typically increases the faculty effort by a factor of four to six and, without costly broadband communications equipment and operating personnel, it is difficult for students to ask questions of the instructor or the instructor to poll or quiz the students.

Additionally, "...teachers usually don't have the time or inclination to explore some new technology."<sup>2</sup> Virginia Tech, as with many other higher education institutions, has been very proactive in addressing these problems with the joint efforts of its Institute for Distance and Distributed Learning<sup>3</sup> and its Faculty Development Institute<sup>4</sup> and the results have been very positive. The Virginia Tech College of Engineering has demonstrated an incredibly strong commitment to the positive use of "educational technologies" and computers in particular in and outside the college. All students were required to have "personal computers" in 1984, "laptops" in 2002<sup>5</sup>, and "tablet PCs" in 2006.<sup>6</sup>

### **ENGE 2314 – A web enhanced programming course**

Engineering Problem Solving with C++ (ENGE 2314) is a 2-credit introductory programming course designed from the outset (1999) to take advantage of Internet and other computer technology to provide for asynchronous distance learning and automatic grading. It was developed within the framework of a custom web "front end" (now termed a CMS) developed "in house".<sup>7</sup> Different formats, applications, and technologies have been tested as they became available with the view of enhancing the students' learning experience and choice while not adding significantly to the instructor's out of class workload. For example, in 2003 MP3 lecture recordings were published simultaneously with the presentation slides.

### **Silicon Chalk™**

Beginning in late fall 2004, Silicon Chalk™ (SC) software was piloted in the classroom.<sup>8</sup> SC is collaborative software designed to enhance the face-to-face experience, allow for and encourage participation of remote students, record the entire process, and make it available to students involved synchronously and asynchronously while eliminating, almost entirely, the additional staff and equipment overhead traditionally required. During this pilot, the primary SC feature implemented was the simultaneous recording (instructor's "desktop" and audio) of the classroom experience during regularly scheduled class meetings with subsequent upload of that recording to the course server. Although several students did bring their laptops, "join" the SC session, and thus record the session on their computers with their synchronized notes, this mode was not demonstrated or tested extensively.

Even with this minimal use of SC features, the in-class experience, and thus the course, was dramatically changed. In previous semesters lectures were focused on the presentation slide model with students taking notes on published PDF files of those slides and MP3 audio uploaded when that became available. Few actual programming demonstrations were done because students had difficulty following the demonstration and simultaneously attempting to take notes without losing some of the steps. Therefore, during demonstrations, class participation was very minimal. Early in the spring 2005 semester, demonstrations became the focus for the entire class period because SC allowed the author to switch between software applications without concern that the students could not follow. As the students also realized that they did not have to take detailed notes, they began to actively contribute to the class. The author first noticed this when the students would instantly correct his inadvertent syntactical errors. In the past, students had been so busy taking notes that they were not really watching the demonstration and did not see the error. Shortly after this, the students began contributing with spontaneous questions such as:

- “What happens if you do this...?”
- “Why can’t you do it this way....?”
- “Isn’t it easier to do it this way...?”

Unfortunately, SC was acquired by Horizon Wimba<sup>9</sup> in summer 2005 and was taken out of production.

### **Camtasia™**

Shortly after discovering the demise of SC, during a short course administered by the VT Faculty Development Institute, the author was introduced to Camtasia™, a product of TechSmith<sup>10</sup>. Camtasia™ does not have all the synchronous collaboration tools available in SC, however, it does have the key component of simultaneous recording of the instructor’s desktop with audio. Additionally, it is much less expensive and does not require the students to purchase or install any additional software as it is capable of producing standard multimedia files in several different formats, all of which are easily played by multiple computer operating systems. Beginning fall 2005, the author began using Camtasia™ in conjunction with a Tablet PC, recording all class sessions and posting them to the course website immediately after class.

### **Results**

Both the author and the students required time to adjust to the new classroom dynamics. For the students, the primary adjustment involved understanding that they would not miss anything if they did not take notes and followed the instructor attentively, asking questions when appropriate. When this understanding was established, most of the students began bringing their laptops to class and following along with the demonstrations. For the author, the primary adjustment involved taking advantage of the features of the Tablet PC and Camtasia™ combination, allowing and encouraging active student participation to drive the class forward.

### **Diversity**

Contemporary introductory computer programming courses are unique in that different students have widely differing computer skills and experience when they start the course. Those with fewer skills and less experience are often discouraged as they observe their peers answer all the instructor’s questions or simply converse in “computer-eze”. The instructor also can easily lose touch with those students who should be driving the course, getting a false view of what is really understood by the majority of students. Unfortunately, many students from under-represented minorities tend to be in the less experienced group. In the new course format, attendance was recorded but not required and, because all students were provided with the video recordings of the lectures and the other information on the course website, many of the more experienced students and those who found the material easy to learn did not attend class. Therefore, the overwhelming majority of class attendees were those students who found the material difficult for various reasons and needed face-to-face contact with the instructor. Once they realized that a majority of their peers in the classroom were at their level, they were more participatory and began vocalizing their questions and taking “ownership” of course direction. Evidence of this is

provided in Table 1 which is a compilation of anonymous survey results from a total of 258 students; 43 women, 215 men.

Table 1

|  | Female  | Male  |
|--|---|---|
| Programming Experience   | 42% None<br>44% Beginning<br>14% Intermediate<br>0% Extensive | 23% None<br>52% Beginning<br>21% Intermediate<br>4% Extensive |
| Class Attendance   | 30% don't attend  | 53% don't attend  |
| Bring Laptop to Class  | 88%   | 84%   |
| Follow Instructor's Demo   | 100%  | 89%   |
| Believe They are More Attentive                                  | 67%   | 71%   |
| Believe There is More Participation                              | 84%   | 78%   |
| Recorded Lectures Bad – Encourages Students Not to Take Notes    | 84% disagree  | 78% disagree  |
| Recorded Lectures Bad – Encourages Students Not to Come to Class | 81% disagree  | 75% disagree  |
| Attending class is more fun, less stressful                      | 74% agree   | 64% agree   |
| Writing on Tablet PC Better than Writing On Blackboard           | 78% agree   | 79% agree   |
| I would not succeed in this course without the recordings        | 67% agree   | 62% agree   |
| The recordings make this course less difficult                   | 84% agree   | 83% agree   |

It should be noted that the number of students bringing their laptops to class has increased from 78% to 100% for women and 63% to 98% for men over the survey period. The only explanation for that increase is word-of-mouth advice being passed down from previous students.

The final exam grade average for the course, which is never returned to the students, is a fairly accurate indicator of student learning between semesters. The exam and its administration have been essentially unchanged for the past five regular semester offerings of the course. Prior to using the class recording techniques (fall 2004) that average was 64.6%. The average reached a high of 70.2% for fall 2006. With respect to diversity, Table 1 indicates significant differences between the female and male students with respect to:

1. Self-evaluated programming experience
2. Class attendance
3. Classroom laptop use
4. Perception of participation
5. Perception of effect of providing recordings

The more positive responses from women on items 2 through 4 are indicative that providing the classroom recordings increases their comfort level in the course more than it does the men. However, the use of the recordings is viewed overwhelmingly positive by a strong majority regardless of gender.

### **Learning styles**

Although learning styles were not specifically surveyed, using the recordings allowed students a great deal of flexibility in when and how they wanted to learn the material. In a different anonymous survey two related questions were asked:

1. “The instructor demonstrated a desire to provide students with the tools they needed to learn the material how, when, and where it was most convenient to them”.
2. “I felt the instructor provided multiple learning tools to support various styles of learning.”

The positive response rate to both of those questions was 82% for both males and females.

### **Accessibility**

Growing numbers of students struggle to gain access to courses they need when they need them or when it is most convenient for them to take them. Students are working an increasing number of hours to help pay for higher education costs. Resource issues are driving course offerings into larger classrooms and fewer time slots so there is less flexibility to deal with conflicts with other required courses and work schedules. Students with disabilities often find it difficult to attend class, or if they can attend, often find it difficult to both take notes and follow the lecture. Students often should not or cannot attend classes for medical reasons. Finally, students are often geographically remote from the campus. These cases are easily dealt with in ENGE 2314 using the combination of the course custom web site, the VT CMS, and the Camtasia™ recordings. “Distance” students take the course semi-synchronously with their on-campus peers.

### **Required resources**

1. Camtasia™ software from TechSmith™ (< \$200 educational price)
2. Tablet PC (standard computer will suffice but tablet markup capability is very useful and effective)

3. Computer microphone (Sony™ WCS 999 wireless with adapter is handy, approximately \$100)
4. Server for serving video recordings (TechSmith™ now offers this service very reasonably if there is not one easily available)
5. Course Management System (custom or licensed)

There is virtually no “learning curve” with respect to the use of the recording software – an instructor can be producing good videos less than an hour after software installation. Once installed and operating, there is virtually no additional time required of the instructor during the class presentation and the time uploading the file after class is negligible for broad band internet connections.

## Conclusions

Educational technology tools such as those described, when properly used in appropriate courses, are beneficial for various reasons including those mentioned herein. The startup and subsequent cost of these tools and their use is negligible, both in real dollars and time. Engineering instructors can experiment with these technologies with very little training, if any, and no risk. When used in a classroom environment such as the one described here, “hands-on” learning increases dramatically.

## Bibliography

1. Ullman, Craig ; Rabinowitz, Mitchell, “Course Management Systems and the Reinvention of Instruction”, *T.H.E. Journal*, October, 2004, [http://thejournal.com/articles/17014\\_3](http://thejournal.com/articles/17014_3)
2. Ibid.
3. <http://www.iddl.vt.edu/about/mission.php>
4. [http://www.fdi.vt.edu/our\\_mission.html](http://www.fdi.vt.edu/our_mission.html)
5. Griffin, O. Hayden; Walker, Thomas D. L., “Faculty and Student Response to a Laptop Computer Requirement for Engineering Freshmen”, *Proceedings of the 2005 ASEE Annual Conference and Exposition, Portland, Oregon, June 2005*
6. <http://www.vtnews.vt.edu/story.php?relyear=2006&itemno=300>
7. Walker, Thomas D. L.; Goodman, Joseph K, “OMEN: An Online Grader for Engineering Programming Courses”, *Proceedings of the 2004 ASEE Annual Conference and Exposition, Salt Lake City, Utah, June 2004*
8. Walker, Thomas; Moore, John, “Work in Progress – Instant Distance Learning Course Development Using Silicon Chalk™”, *Proceedings of the 2005 Frontiers in Education Conference, Indianapolis, Indiana, October 2005*
9. <http://www.horizonwimba.com>
10. <http://www.techsmith.com>