Laptops in the Classroom

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Abstract

This paper focuses on a rapidly growing population on many college and university campuses today: students equipped with laptop computers capable of wireless connection to the Internet. More and more departments are requiring that students enrolling in certain courses bring laptop computers to class. The course instructor is some–times overwhelmed by the prospect, asking "How should I change my lesson plan in order to integrate the laptop in my daily lecture?" This paper first describes the effort to bring the laptop to campus at a number of colleges and universities around the country. It then offers concrete suggestions based on the experiences of several professors who either have taught, or are now teaching, laptop-required courses. The paper concludes with a summary and a look toward the future.

1 Introduction

The classroom is rapidly evolving. It is common place today to find students required to bring programmable and graphing calculators of a specific brand and model, a teacher provided with an Internet-wired computer whose output is projected onto a screen, or students in computer laboratories full of desktop computers connected to each other and to the Internet. And most recently, some colleges and universities have mandated that each student own and bring to class a laptop computer with a wireless connection to the Internet. All of this technology is introduced in the hope that the tools will augment teaching and learning. *Therein lies the challenge.* The teacher is faced with the sometimes-daunting task of effectively integrating the electronic device into the day's lecture. This paper focuses on the availability of laptops in the classroom and presents several ideas on how the teacher may use them to their advantage.

2 Background

A variety of approaches to enhancing the classroom experience are being taken by educational institutions. For example, the University of Arizona, Tucson, is developing learning centers, i.e., classrooms equipped with state-of-the-art technology in which professors use instant-feedback and multiple-choice voting. Results are electronically tallied allowing the professor to adjust a lecture to provide additional information as needed. [15]

Wireless networks are no longer experimental and have been built into school classrooms and libraries. These include the University of Florida, Colorado State University, and at Greenville College in Illinois where students can wander virtually anywhere on campus and be connected. [13] The State University of New York (SUNY) at Morrisville has been named the "'most wired' two-year college by Yahoo Internet Life. [21]

Clemson University began a pilot laptop program for 100 freshmen in the Fall 1998 semester. [18] In Fall 2002, over 2300 freshman and sophomores are in courses requiring laptop computers; the number of students with laptops is expected to double over the next two years. The University of North Carolina at Chapel Hill "supports a laptop requirement that will reach 15,000 undergraduates by fall 2003." UNC has formed an alliance with Cisco Systems for a wireless laptop environment. [3] In 1999, the College of Engineering at Mississippi State University mandated laptop computers so that, in class, computer science students could step through animations of programming constructs, take notes, and run instructor's examples for experimentation. Online quizzes are used with feedback provided within 24-hours. [8]

The new laptop wireless environment is proving to be a savings for the school and a convenience for the student. Now that the college students have access to computers without having to go to a remote section or lab on campus, computers are becoming ubiquitous. Budget conscious universities are realizing that requiring students to purchase laptops can reduce the need for expensive multimedia classrooms. [1]

Carnegie Mellon is working on "'invisible halos" of computing surrounding participating student and faculty. The argument is that computers have become too much of a distraction and that future networks should be invisible and pervasive in which people and computers "interact through proxies and auras." [14] The Aura Project, financed by the Department of Defense, allows computer users to use voice commands to sort e-mail, display information on a wall-sized video screen, or use a service based on wireless network management software to locate students who have a wireless handheld device or laptop turned-on.

The May 1998 Best Practices Conference held at the International Center for Computer Enhanced Learning at Wake Forest University addressed the topic of ubiquitous computing. Speakers described different models of computing including: 1) anytime-anywhere laptop computers (Wake Forest model), 2) powerful desktop computers in all student rooms (Air Force model), 3) powerful anytime-anywhere laptop computers (Valley City model), and 4) threshold computer requirements, with portability and power, left for each student to decide (Sonoma State and Virginia Tech models).

Using computers to encourage more effective learning was addressed at the conference. However, the details in developing curriculum and methods of using the laptops as a pedagogical tool were not. The issues that were addressed related to more effective teaching and learning, and they were applicable at the macro level of using the laptops in the classroom. The issues addressed included: 1) that faculty develop ways to use the computer as a more effective communication tool; 2) that faculty have "ownership" and an active role in "setting policies" to "enhance teaching with technology; 3) that the computer network used must be reliable or student and faculty interest will be lost; 4) that faculty must be able to predict performance and have realistic expectations; 5) that faculty can recognize and use different techniques to impart subject material and accommodate various learning styles; 6) that universities must invest in training for faculty and students at the moment of learning new material and provide support; 7) that the focus be on "teaching and learning" instead of enhancing the elaborateness of the system; 8) that laptop computers provide a holistic opportunity for pedagogy by continuous communication, i.e. "notes sent out in advance" and "questions to the professor"; and, 9) that one must view the "computerization of a campus as a system" that must be maintained and supported along with "faculty development." [1]

3 Problem Statement

Much of the available literature for laptop computing discusses topics such as logistics, hardware requirements, training for faculty on the use of computers, and laptop management. Precious little has focused on pedagogy. This is what we address in this paper. We ask:

> How can the instructor do a *better* job of teaching given that a laptop computer with a wireless connection to the Internet is available to each student?

We emphasize that the instructor must be a *better* teacher. If he or she is only *equally* effective with laptops present, then the computers may as well be left in the student dorm rooms.

4 Blending the Laptop into Lecture

This section discusses eight general categories; under each are listed specific suggestions, conclusions, or anecdotes either found in the literature or collected from interviews with professors at Clemson University, all of whom are teaching laptop-required courses. The objective is to provide the reader with specific and concrete ideas on how to integrate the laptop into the lesson plan. The hope is that with these ideas, a little time, and some experience, the reader will be able to blend the laptop into his or her daily lecture, rendering it effectively invisible.

4.1 Posting Instructional Material Online

All of the professors interviewed make their notes available on the web. These range from PowerPoint presentations to MS Word documents to HTML pages. Most students download and print the notes, and add additional notes during lecture.

One professor also makes extensive use of MS NetMeeting's Whiteboard [9] in the classroom. During lecture, he uses a physical electronic board and an electronic stylus [7, 10] to write and project notes onto the screen. The notes are saved as a PDF file after class and posted on the Web.

A history professor asks his students to research a topic on the Web and to develop a website to teach other students. His experience is that, without guidance, students tend to visit a superficial encyclopedia and prepare a site with insipid content. He has found that spending time to prepare a *reference* website with carefully selected links, and then restricting the students only to the links listed, enables the students to develop better website reports. [2]

4.2 Animating and Demonstrating Concepts

If a picture is worth a thousand words, how much is animation worth? It is worth quite a bit more, according to one professor who regularly uses applets as a visual, interactive supplement to the lecture. [16, 19] For example, a site by Gogeshvili [5] makes available BTApplet.class, an *excellent* applet-based animation of binary search trees, AVL, splay, and red-black trees. Spending the first half of a class period with a traditional lecture on any of these topics (with laptops closed), followed by fifteen minutes of a structured laptop exercise using the applet, can deliver the concepts quite effectively.

A statistics professor uses NetMeeting to allow students with laptops to take control of, and work with software running on, the professor's computer. For example, a student can take control of a spreadsheet and demonstrate to the rest of the class how to compute the standard deviation of a column of numbers. With the professor's permission, control can be passed from one student to another providing a means for graded "recitation." Although only one computer is in control at any time, all students linked to the NetMeeting can view the spreadsheet activity on their own laptops. Students not linked can view the image projected from the professor's laptop onto the screen. [7]

A math professor walks the students step-by-step through an online worksheet that leads the student through the solution process of a math problem. Graphical representa-

tions of the intermediate and final functions facilitate student understanding. [11]

A chemistry professor uses QuickTime movies to demonstrate potentially hazardous chemical experiments. He uses an interactive software package that accompanies the textbook and provides students with immediate access to information on every element in the periodic table. The software also has molecular modeling program. [4]

4.3 Collaborative Learning Exercises

One study concludes:

> "For collaborative learning to be effective, the instructor must view teaching as a process of developing and enhancing students' ability to learn. The instructor's role is not to transmit information, but to serve as a facilitator for learning. This involves creating and managing meaningful learning experiences and stimulating students' thinking through real world problems." [6]

Collaborative learning exercises are difficult both to design and to assess. Often, one or two dominant personalities take the project over and dictate the solution to the rest. The best advice appears to be: keep the exercise simple.

A chemistry professor gives his students the following problem: "You need some ____ for a chemical reaction and are trying to figure a way to make it. Does it look like any of these routes work?" and he offers four suggestions on how to develop the required compound. He allows the students to work with an interactive software package in a group for about 15 minutes. Then each student has till the end of the class to write a paragraph about what their group did. Student reports are graded 1 or 0, representing "engaged" or "not engaged." [4]

A computer science professor gives team Java programming assignments requiring development of two to four classes. Each student is required to develop one of the classes. The team is allowed to discuss design and implementation issues, but each student must write and test his or her class individually. Java servlet software developed specifically for this type of assignment allows web-based submission of each student's code. When all team members have submitted their classes, the code is automatically compiled and run against the professor's test-driver. The results, including any compiler or runtime errors, are immediately viewable on the web. Students are allowed to discuss and correct errors, and resubmit code. Students are graded partly on the success of the team and partly on the performance of their individual classes executing with the professor's code.

4.4 Instant Feedback

Instant feedback is a major advantage enjoyed by a laptop-required course over a traditional course. One professor believes the success of the laptop in the classroom will be due to the informative feedback that the professor receives when he or she walks around the classroom and sees how students are solving problems and accomplishing their tasks. [12] Software tools are available that allow quick development of online quizzes or short surveys. Survey questions such as: "Did you prepare for today's class? What is the point in today's lesson? Did today's group activity work for you?" asked at the end of a period can give the professor insight into how effective the day's lesson was. The results of a short quiz at the start of a period, automatically tallied and immediately available, can indicate that a certain topic should be revisited in today's lecture. A short quiz on the assigned reading can suggest what percentage of the class actually did the reading.

Feedback also works in the other direction. Students can get the results of their quiz instantly. Programs can be submitted for automatic compilation and execution. The professor can demonstrate in real-time how to develop particularly difficult sections of code; the students can follow on their laptops. The professor can go around the classroom pointing out specific problems students may have, problems that would otherwise have taken the students hours to debug. The master/apprentice model of education comes alive in a laptop-required course.

4.5 Automatic Program Execution and Visualization

A computer science professor is developing new software tools to facilitate evaluation of assignments, specifically programming assignments. [17] The tool enables a student to develop a program and submit it through the Web. The program is compiled and tested by a driver developed by the professor. The results are returned to the student, also through the Web. The results can be text output produced by the student program, or can be a graph plotting the execution times of the student program with different inputs. The professor can display results produced by several students side by side and compare their output. The ability to get early evaluation of assignments rewards the more diligent students.

A math professor uses MAPLE [20], a mathematical, software package where students can visualize their work in a Calculus III course. He believes that software run on student laptops permits him to teach topics which involve, for example, 3D visualization, which could not otherwise be taught or modeled. The interactive software allows the students to manipulate the models under the direction of the professor in the classroom. [11]

4.6 Evaluation and Testing

Most of the professors interviewed use one or another form of online testing. All readily admit to having problems with cheating. A professor with a large lecture class relates that even when he used password protection, with the password announced seconds before the test started, he still ended up with ten more submissions than there were students in the room. Students were emailing or instant messaging the password to their absent friends. He also relates that restricting the IP address to a specific subnet (all of the wireless laptops in the classroom have IP addresses with that subnet) eliminates the problem of students in the dorm rooms illegally taking the test (their

laptops have an IP address in a different subnet), but does not solve the problem entirely. Laptops *not* in the room but *nearby* (in the hall, in the next room, or outside the window) are able to tap into the same wireless subnet connection as students in the room.

Another problem is the fact that some students try to surf the Web, without permission, during a test. One solution may be to make the test "open book and open Web." Some argue, though, that this gives students a false sense of security causing them to do less well because they study less and spend more time during the test reading and surfing. [4] The problem of cheating during online major tests remains a problem in serious need of a solution.

Fortunately, there *is* a brighter side to online testing. As mentioned in Section 4.4, when the test is a short quiz, a survey to measure student satisfaction with a particular exercise, a quick check to see how many did the reading assignment, an online test is a wonderful tool. It can help the professor gauge the level of student understanding of a particular topic and suggest that the planned lecture for the day should be adjusted slightly. The surveys can reveal student dissatisfaction early enough in the semester for the professor to make corrective changes.

One final note: on any given day, it is possible, indeed likely, especially in a large class, that one or more student laptops will be broken. Projecting the questions onto the screen or bringing a few printed versions of the quiz sidesteps this problem.

4.7 Communication

The laptop environment provides more opportunities for communication between faculty and students. For example, NetMeeting allows off-campus speakers to lecture in a class, or for the professor to meet his class while out of town. Although it is possible to use NetMeeting to transmit real-time audio and video, in practice, an advanced speakerphone is better. Notes may be written on NetMeeting's Whiteboard and students can ask the professor questions through the speaker phone. Lectures can be prepared in advance in PowerPoint and projected onto the screen in conjunction with the whiteboard.

NetMeeting allows a sick student or a person at a remote site to participate in the class. The student can log onto NetMeeting at home and use a phone to ask the professor questions. Through the speakerphone, the student can hear the lecture and other students' questions. The student may also contribute to the class through their phone.

Students are very comfortable emailing questions to their professors, particularly when an assignment due date is near. An effective way to communicate information to the entire class is to remove the student's name from the email and to broadcast the response to the entire class. Instructions are uniform and no student is left out of the loop.

Review sessions before a test no longer need to be face-to-face meetings. NetMeeting or chat rooms provide a way for the professor and the students to hold a virtual meeting at a designated time. If an electronic whiteboard is available, then the professor can illustrate his answers with diagrams.

NetMeeting also facilitates lab sessions with one person in the lab and the lab partner at home or work. In this case each student in the lab can be paired with another student at a remote site. For example, the student in the lab can be running a particular software package, and the student at the remote site can Instant Message their partner in the lab or speak to them over a headset or telephone, if the person in the lab has a headset. The paired students can communicate with each other on solving the problem by using the software on the lab computer. In addition, each student in the lab has a partner and the lab session is conducted the teacher as normal.

4.8 Laptop Etiquette and Discipline

An interesting assortment of laptop-etiquette rules and regulations emerged from the interviews with the professors. We list them here in no particular order.

(1) Every cell phone, beeper, laptop volume control, pager, personal digital assistant, should be set to *mute* or *off* before coming to class. If any of these devices rings, beeps, or plays in class, you will be marked *absent*. (2) Bring your laptop to class every day. (3) Laptop batteries should be fully charged before coming to class. (4) Laptops may not be opened until told to do so. (5) Bring your laptop in *sleep* mode to avoid long boot up times. (6) If you engage in unauthorized communication or entertainment (surfing, instant messaging, chat room chatting, DVD viewing, music playing, game playing, etc.) during a quiz, you will receive a grade of 0 for the quiz. A second offense will result in a formal written charge of academic dishonesty. (7) If you engage in unauthorized communication or entertainment during lecture, you will be marked *absent*. (8) If you forget to bring your laptop and a quiz or exercise is given that requires a laptop, you will receive a grade of 0 for that quiz or exercise. (9) Students participating in a NetMeeting should not request for control of the screen until the professor grants permission to do so. (10) Do not shutdown your laptop unless the professor grants permission.

5 Summary and Future Work

The use of laptops in classrooms is still in its infancy. More and more universities are requiring their incoming freshmen to have laptops when they arrive. More and more classes are being designated "laptop required." Very few faculty members, however, have been given guidance as to how to integrate the laptop computer into their daily lecture. Moreover, current papers on the topic focus more on managing wireless environments, the logistics of requiring laptops at a university, system administration, and different laptop environment models. Very few address the topic of how pedagogy can be enhanced with the presence of laptops in the classroom. Most faculty members have simply taught themselves and learned almost purely from experience.

This paper attempts to bring together some of the experiences of professors who either have taught, or are currently teaching, laptop-required courses. The paper presents eight general categories under which the advice, suggestions, and anecdotes of these professors are listed.

Laptops will continue to be used in the classroom only if they become effectively *invisible*. By this we mean that the laptop computer should blend into the lecture and the students' learning experience and not be a distraction, or an obstacle, obstructing the intended lesson for the day. The laptop should be able to illuminate aspects of the lesson that could not be seen without it. In a very real sense, the laptop should be noticed only when it is *absent*.

To accomplish this, we need much more experience and experimentation with the laptop in the classroom. Workshops for current and aspiring instructors of laptop-required courses should be conducted in schools at least once a semester and once in the summer. Frequent communication among current laptop-course instructors through email, or bulletin boards, should be encouraged. If the college or university is serious about developing a collection of laptop courses, administrators should support the instructors through the purchase of hardware and software, and *especially* through course release, in order to provide instructors with the time necessary to develop new exercises and new teaching techniques. If the instructor views the laptop as an additional burden on top of his or her normal load, all enthusiasm for the laptop in the classroom will dissipate.

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