Technology + Innovation = Pedagogy

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Introduction

Clemson University's pilot laptop program ran from fall 1998 to spring 2002 and resulted in implementing a phased plan for all students to arrive on campus with laptop computers. During the pilot, selected faculty designed, developed and taught laptop sections of existing courses. That effort increased in summer 2002 through the creation of the Laptop Faculty Training Program and the award of laptops to 57 faculty members representing all five colleges. The following are examples of the resulting innovation in teaching.

Studio Calculus III and Differential Equations

During the pilot laptop program, Bill Moss developed laptop versions of sophomore calculus III and differential equations. Last spring he began to investigate the studio approach to teaching calculus and physics, which was developed at RPI in the early 1990s and has since spread to a number of schools. This academic year, he developed studio versions of calculus III and differential equations and used the Linear Algebra Modules Project materials for a studio version of Clemson's linear algebra course. Fall 2002, he taught the first unit of calculus III in the traditional way and then began the studio approach with the second unit. At the end of the second unit, he collected student feedback: 18/33 absolutely loved the studio approach, 4/33 were neutral, 11/33 did not like it for various reasons. Most of the students provided helpful suggestions for improvement, which he incorporated for the third unit of material.

Moss devotes the first 10-15 minutes of class to class business and a mini-lecture on the current topic. During the remainder of the class period, students solve problems in their course journal or in a Maple tutorial worksheet, while Moss roams the room to watch students work and coach students who are having difficulty. The Maple tutorials contain instructional objectives and suggested problems for each objective, a synopsis of the main ideas with examples worked in Maple, a list of problems to be done by hand in the student's course journal, and a set of problems to be done with Maple. Each student submits three to four tutorials per week electronically along with a selection of journal problems. The hour exams and final exam are hybrid. About half the problems must be done by hand showing all work and the remainder are done with Maple and submitted electronically. Outside of class students work in teams of three on more advanced engineering problems.

This is Moss's 34th year of teaching, and he is finding that coaching students in a studio setting is far more rewarding than lecturing. Coaching time is informal; students are often working in groups, comparing answers and helping each other. By watching students work during every class period and answering their questions, he can track the progress of each student far better than he could previously.

Data Structures and Algorithms

Roy Pargas utilizes laptops in the computer science classroom in three ways. First, in a course in computer data structures, he is testing a *master-apprentice model* of instruction. Computer data structures are building blocks used to construct complex software systems; a primary goal of the course is to provide the students with the understanding and skill to select and use the *best* data structure for a software component being developed.

Traditionally, the instructor graphically describes the behavior of a data structure on the board, drawing and erasing segments as the dynamic data structure grows and shrinks. Some students attempt to follow by copying the instructor's sketches; others prefer to focus on what the instructor is doing and refrain from taking notes. Typically, the former fail to fully understand the behavior of the structure, whereas the latter lack reference material when attempting to repeat what the instructor did. With laptops, the students can download applets (small interactive programs) supplied by the instructor on the course Web site. The students manipulate the applet and discover for themselves how the data structure behaves. Pargas provides guidance in how to elicit subtle behaviors from the structure and an exercise to guarantee that students probe every important aspect of the data structure.

This approach provides several advantages over traditional lecture. (1) Students spend class time actively manipulating and studying the data structure,

rather than taking notes or passively watching the instructor. (2) Students have the applet, allowing them to work with it out of class. (3) The instructor need not spend much time lecturing and can roam the classroom to help students who may be struggling. The model Pargas envisions is a *master* guiding a room full of *apprentices*, instructing some but leaving most to discover the material on their own.

Second, Pargas is researching the *automatic* compilation and execution of student programs submitted on the Web. This tool will provide students with immediate feedback on how their program compares with expected results, allowing the student to make changes before final submission.

Third, a companion software tool is also being developed, one that analyzes a program's layout, documentation, and programming style. The tool will measure how well a program adheres to the programming style guidelines provided by an instructor. With this tool, a student can receive feedback on stylistic deficiencies or layout errors.

Microsoft® NetMeeting® in the Classroom

For several years, Larry Grimes has successfully used Microsoft NetMeeting, especially the whiteboard feature, with his experimental statistics students in the classroom. The program's features allow flexibility in presenting and preserving material and in communication with and among students. This, in turn, enhances the quality and clarity of presentation and the overall learning experience.

Microsoft NetMeeting is free software that allows computer collaboration via the network (or Internet). It usually already exists on Windows computers. Available functions include a digital whiteboard, chat, file transfer, software sharing, audio communication, and video communication.

The digital whiteboard allows for handwritten notes to be displayed and saved (using ADOBE Acrobat Distiller) for later review. Screen captures of any software or image are easily pasted on the whiteboard for annotation. Whiteboards can be prepared in advance similar to PowerPoint. All students collaborating in a class can be allowed to write on the whiteboard as authorized by the instructor. Grimes uses the whiteboard in the place of a chalkboard to display lecture notes, to work through problems, and to aid in demonstrating various software.

Software sharing allows one member of the collaborating group to open an application (not necessarily available on all the computers) in such a way that it can be viewed simultaneously by all other members of the group. Control of the application can be shared one at a time with other students. This facility is excellent for training, demonstrations, and document collaboration. For example, students can work through the solution of a statistical problem using the SAS (statistical software) program resident on a computer while the rest watch. Mistakes that are made can be pointed out quickly so that corrections can be made in a timely manner. Also, students can work in pairs and collaborate on working through a statistical problem. Using a computer headset, students can talk while they work together on a problem. This can be done from anyplace where there is Internet access so there is the capacity to do this without physically coming to the lab or class.

The chat component is similar to other commonly used chat software and allows students to send messages to the entire class or any particular student. The file transfer tool does just what it says and is reasonably easy to implement.

Written, Oral, and Digital Communication

Teaching English and communication studies courses in a laptop environment freed Barbara Weaver to move beyond the traditional boundaries of the classroom to explore possibilities with other faculty and her students. Some of her successful laptop assignments are cross-discipline projects that allow the students to apply their written, oral and digital communication skills. In general, literature and public speaking courses are among the more difficult courses in which to integrate laptops. In literature courses, instructors traditionally rely heavily on lecture and class discussion. In public speaking, much of class time is spent having students deliver speeches. For both disciplines, the likelihood of laptops being a distraction is high. Weaver maintains that restructuring class time and developing new assignments is the key.

For example, in her contemporary literature class, Weaver's students used class time to plan, develop and rehearse a program associated with Arts in April, a campus-wide focus on the arts. Their program began with a concert by Professor Linda Dzuris's carillon students followed by the literature students' multimedia presentation on the Beat poets. Students formed teams to research selected poets and then develop their presentations. When the teams' work was completed, the whole class compiled the team

presentations into a seamless multimedia file and a printed program. Their class presentation ran on one student's laptop and was projected onto a large screen. From invention to post-project review, Weaver coached her students to discover and claim their knowledge of the course content.

In a public speaking course, Weaver uses a project with the S.C. Botanical Garden Sculpture Program. The students form teams to design, develop and deliver a multimedia presentation on the current year's sculpture to elementary school children. At the sculpture site, students help the artist install the sculpture and document on their laptops and with digital cameras their observations of the process. When they have collected all of the necessary information, each team develops a presentation designed especially for the elementary class they are assigned. They travel to the school to deliver the presentation that is digitally videotaped, converted to a movie file, and uploaded to Clemson's network. Students watch their presentation on their laptops to gain a better understanding of their skills. Weaver's students report they gain more from the workshop environment in the classroom, their research in the Garden, and the presentation for the children than from lectures and giving speeches to their classmates.

References

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