Miracle or

Teaching and Learning with Laptop Computers in the Classroom

A study of integrating laptops into classroom instruction found statistically significant improvements in student learning

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All freshmen at the United States Military Academy at West Point now have laptop computers to use in class. Several instructors for the General Psychology course that all freshmen take are currently incorporating classroom learning activities and strategies to leverage the technology tools available with laptop computers. The purpose of the study reported here was to examine teaching techniques, lessons learned, and student performance during the integration of laptops in teaching and learning psychology in the traditional classroom. The goals behind introducing the laptops were to enhance teaching practices and efficiency and positively influence student learning and attitudes toward psychology.

We initially attempted to integrate laptop technology into the classroom during our summer teacher training sessions. We soon discovered that the returning faculty members participating in these training workshops were not very motivated to integrate the technology. Many instructors felt uncomfortable teaching students who were actively pounding keyboards to take notes. Additionally, many faculty members believed that students would engage in activities not related to the class. Giving up this control in the classroom was not acceptable to some faculty. One faculty member stated outright, "My students won't be using those laptops in my classroom." Initial faculty attitudes had an adverse impact on our attempts to get students using laptops in the classroom.

Another critical limitation influencing faculty adoption of laptops was whether faculty members actually owned a laptop. During our faculty training, we used loaner laptops, returning them before classes started. We soon discovered that faculty members were much more likely to attempt using laptops in the classroom if they actually had a laptop. Fortunately, we acquired four laptops for the four instructors who participated in this study. Subsequently, when we issued laptops to the six new instructors on our faculty this year—the semester after this study was conducted—all six aggressively worked to integrate laptop technology into their classroom strategies.

The students provided another hurdle to laptop integration. Because this was the first year that the academy had laptops in the classroom, the students also were quite dubious about the utility of this technology. They definitely saw advantages to doing e-mail and instant messaging in class, but the advantage of using the laptop as a tool for learning was not evident at first. Several students simply resorted to taking notes with paper and pencil, a closed laptop beside them.

What follows is an overview of our quasi-experimental[1] study examining

Menace:

the effects of integrating laptop computers on teaching practices, student learning, and student attitudes. We highlight specific teaching practices, student activities, and lessons learned throughout our discussion to help colleagues evaluate our experience and consider laptops for integration into their classrooms.

Method

Our study involved a quasi-experimental design with 10 instructors. Student exams and surveys assessed success of laptop integration in the classroom.

Participants

The study involved 10 General Psychology instructors who taught 527 freshmen in 30 classroom sections (average 17 students per section) at West Point. Students were randomly assigned to their classroom sections. The instructors and students used the same textbook, curriculum, learning objectives, and exams.

Design

The 6 instructors in the control group did not incorporate laptops into their teaching strategies for 22 student sections, while the 4 instructors in the experimental group used laptops to facilitate learning activities in class for their 8 student sections. The four volunteer instructors in the experimental group varied in experience: one had a Ph.D. in education; the other three had masters' degrees in psychology. The average teaching experience for the experimental group was 2.5 years.

In the control group, one of the instructors had a Ph.D. in psychology; the other five had masters' degrees in

psychology. The average teaching experience for the control group was 2.8 years.

Measures

Six exams (a combination of multiple-choice and short-answer questions) and a final exam (100 multiple-choice questions with reliability of $r = .81$) assessed student learning of course material. All exams were the same for all students, taken at the same time. Instructors held "calibration" sessions before the exams to maintain consistency in grading criteria. A typical end-of-course survey assessed student attitudes toward the course and the integration of laptop technology.

Because the academy was in the process of configuring classrooms for wireless technology, we used three different types of technology classrooms to simulate a wireless technology environment. One instructor had access to a wireless-ready classroom, one instructor used a standard desktop lab that simulated wireless capability with a server, and two instructors used laptops in a traditional classroom with limited wireless capability. Ironically, even in the most wired, hi-tech classroom, several students refused to use their laptops and took notes the traditional way, with paper and pencil.

As we present our teaching methodologies and findings, we will highlight the influence of laptop technology on student performance and attitudes as well as its impact on teaching efficiency. Even miraculously positive results on student learning could be discounted if the use of such technology proves a menace for teachers to integrate into their daily practices.

Bringing Learning to Life

What follows are various techniques and strategies used in the laptop sections to "bring learning to life"—to enhance student attitudes (interest and motivation)—and various techniques to facilitate practice and feedback. By having students use the laptops in the classroom, the teacher has more instructional and classroom tools available. For example, one technique of bringing learning to life is to make sure the students feel that the concepts covered are relevant to them. A method for doing this is assigning a different student each class session to give a short (two to three minutes) briefing at the beginning of class about a psychological principle that is interesting or relevant to them. The student shares the presentation with the class by putting it in the class digital drop box. Not only has this student personalized and internalized a concept from class, but now the rest of the class has access to this student's digital presentation as well.

The advent of wireless networks across campuses fits hand-in-hand with laptop use. A wireless network is not just for students to use in the library or their dormitories; it also should be used by students and instructors in the classroom. An instructor can have all the students during a class simultaneously visit specific Web sites related to the current topic. The Web is full of interactive and interesting sites that quickly and efficiently demonstrate key classroom concepts.

For example, after a lesson on prejudice and its reduction, a student found the tolerance.org Web site. This site has a feature that maps the location of

known hate groups throughout the country. The student forwarded that site to his teacher, who forwarded to the other teachers, who then forwarded it to their students. Within three minutes of forwarding the site to students, the instructor got a response from a student who had checked her home state and found out that there were known hate groups right in her back yard. She wanted to know why the authorities allowed the hate groups to function if their existence was known. It is clear that the reality of prejudice was brought to life for that student.

Certainly, the above interaction could have happened without any of the involved parties using a laptop. We find, however, that our students use their laptops in the time between classes to check e-mail or accomplish other class-related activities. What is so encouraging is the progressive interaction: A student inspired by the class used his laptop at the first opportunity to do more research, then shared it with his instructor. Another student then visited that site and had a "real life" learning experience. Without a laptop to use for quick access, the first student might have forgotten his interest in the class and not found tolerance.org. Consequently, the second student would not have gotten the address and would have missed an eye-opening moment. This example shows how having a laptop to use in class provides indirect benefits in bringing learning to life.

Web sites can be used to introduce topics, generate discussion, and solidify points. For example, the instructor can have students go to a particular Web site that illustrates or introduces concepts and phenomena related to content covered in class. These sites often spark interesting discussion and debate that really engage the students' interest. Similarly, after covering an abstract psychological concept, the class can go to a Web-based exercise that illustrates the concept in action. Finally, often topics come up for which the instructor did not prepare or that are outside the scope of class but that
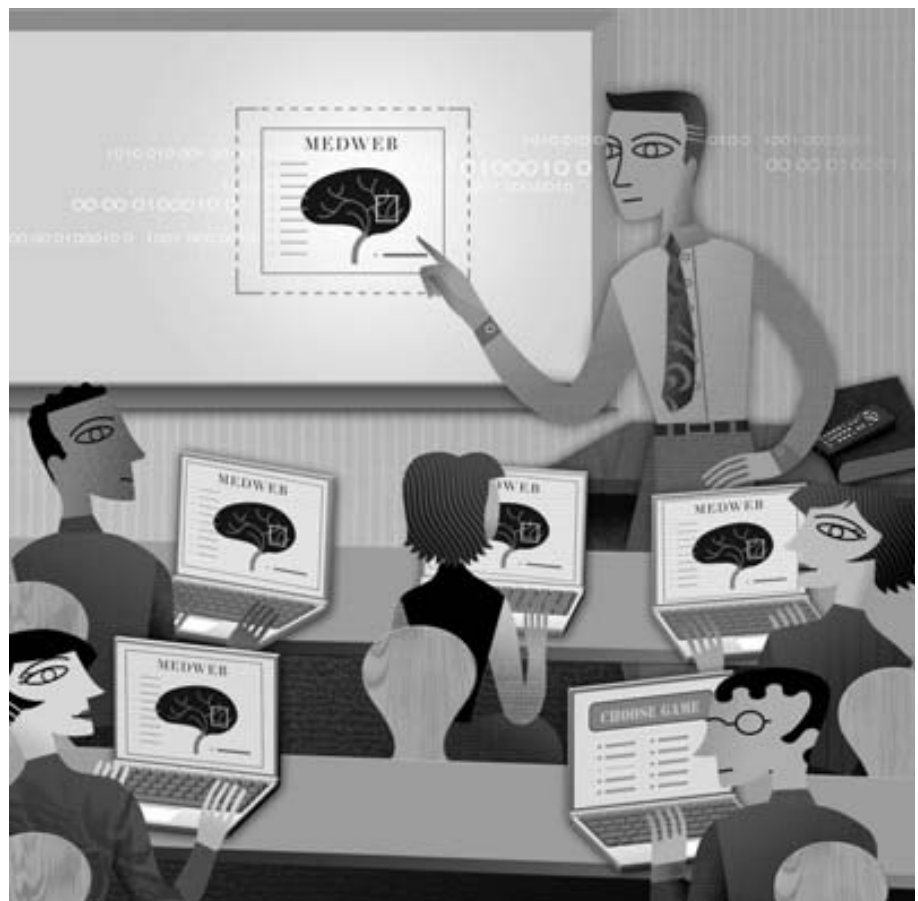
can quickly be looked up on the Web. Quick, in-class research is a great tool.

Suppose the day's class is on sleep deprivation. The instructor could say, "Okay, student X, I want you to find who holds the record for the most consecutive hours without sleep. Student Y, find me five symptoms of sleep deprivation." Within five minutes, the instructor and the class would have the answers. This easy, quick activity increases the students' motivation, keeps their interest by giving them in-class activities, and ultimately contributes to learning.

Students can also "go to the library" without leaving class. The libraries at most colleges and universities allow students to access numerous journals, databases, and indices via their intranets. Many of these journals include links to full-length texts that can be referenced or printed out right in the classroom. This ability provides a great tool for in-class research—an instructor can teach and supervise students as they learn how to conduct academic searches and scholarly

research. This task previously required taking the entire class to the library or having them watch the teacher show them an example of research on the main class computer. Students learn better by doing, and the laptop computer allows all students to "do" while the teacher monitors.

If there is one activity today's generation enjoys, it is playing computer games or simulations. In an extensive literature review Means et al.[2] found that simulations increased student motivation and provided a more concrete context for meaning, which in turn increased student learning. Similarly, Wenglinsky[3] found that real-world simulations increased both performance and motivation in eighth grade math students. Since this motivation already exists, the key is to harness the interest and bring it into the classroom.

When teaching the experimental method, for example, an instructor could use any number of computer games to test the effect of some "experimental potion" on the hand-eye coor-

dination of students. The instructor could have the students design the study, develop the hypothesis, figure out how to choose participants, divide the participants into a control group and an experimental group, and conduct the experiment by taking the "potion" and playing the game on the computer. In an hour-long class, the students can execute the entire experimental method: gathering the data, analyzing the results using programs on the laptops, and even talking about methodological problems associated with the classroom experiment.

Another great use for computers is digital media. Nothing captures students' attention like a clip from a popular movie, television show, or funny commercial. Boster et al.[4] found that video clips integrated into a lesson plan resulted in increased student achievement.

Using digital media with laptops has advantages that go beyond digital media shown on the central classroom computer, leveraging its effects on motivation and learning. With digital media, an instructor can share with students—via e-mail or other techniques—the digital clips used in class to illustrate a lesson.[5] We have found that students share these clips with friends and family, explaining the relevant psychological principles when they do. Any time we can get our students excited and talking about our discipline outside the classroom, it is a good thing.

Nearly all introductory psychology textbooks now include a companion CD-ROM. Most instructors and students seem to ignore this valuable learning tool with its simulations, demonstrations, and exercises that often can be used in the same manner as Web-based exercises. These exercises are usually fun and interesting, and comments from students indicate that they motivate them to learn. Before laptops in the classroom, instructors could assign these exercises as homework, suggest that students look at a particular demonstration, or—at best—demonstrate something on the classroom computer for all to watch.

With the CD-ROM, the instructor no longer has to wonder whether the student did the assigned simulation, nor does the student simply watch as the instructor performs the exercise in front of the class. Now each student can use a CD to do the class exercise while the teacher monitors everyone's progress. These exercises, demonstrations, and simulations typically only take 5 to 10 minutes of class time, and at the completion each student has had a common experience that can lead to richer classroom discussion. Additionally, by putting into practice concepts just studied, the CD exercises tend to fix the concepts in the students' minds. They now have a visual, auditory, and tactile tie to what they have read for homework the previous night and what was covered in class that day.

For example, one of the simulations on the CD-ROM that comes with the textbooks we use is "Morphy the Rat." This simulated rat in a cage represents a Skinner Box. The students can "train" Morphy, using shaping and positive reinforcement, to perform a series of tasks. At the beginning of the lesson on operant conditioning, the teacher can have everyone engage in the simulation using their laptops. Five minutes later, the entire class has put into practice the principles they studied the previous night. The final 40 to 45 minutes of class can now build on this experience in a variety of ways. The principles of operant conditioning that may have been foggy and unclear to the students while doing the homework have come alive in an interesting, engaging, and interactive manner.

Practice and Feedback

This section summarizes various techniques for using laptops effectively in the classroom. These techniques affect the efficiency of classroom procedures while promoting learning through responsive feedback enabled by technology.

Digital Syllabus

An editable, digital syllabus (skeleton outline of the lesson plan) lays out the "big picture" lesson objectives as well as the lower-level performance objectives that spell out the concepts with which the students must be familiar before attending class. The digital syllabus lets students prepare lessons on their laptop computers by adding notes in a different color to the syllabus. Taking notes in a different color makes it easy for the student to follow along in class; it also makes it easy for the instructor to identify which students have prepared for class.

While in class, students can use a third color to update or correct their notes as required and to highlight those concepts on which the instructor focuses. By the time class ends, the student has produced a personalized resource for future use and study.

"Beam Solutions"

The instructor can use wireless capability to "beam" student homework solutions onto the classroom chalkboard or dry-erase board for review. The wireless network allows for quick transfer of homework or in-class assignments to a digital drop box that can be accessed by the classroom computer to which the overhead projector is attached. If classrooms are not wireless, students can bring in disks to upload homework onto the classroom computer. Once homework solutions are in the digital drop box or on the classroom computer, the instructor can "beam" any student's solution onto the board where it can be annotated to illustrate either common pitfalls or exemplary work. Since the source file was created on the laptop, the owner of the on-screen assignment can correct his or her work as the teacher does. At the end of the exercise each student has a correct example of a given type of problem.

Compare this technique to doing in-class work on chalkboards. When solving problems or doing homework on the chalkboard, any feedback or corrections end up erased at the end of class. Also, using actual student responses seems to be more meaningful to students than "canned" exam-

ples that may or may not cover specific difficulties that students encounter.

Software Interaction

Instructors can incorporate discipline-specific software in classroom exercises. For example, our instruction on correlational research incorporates an in-class exercise in which we try to correlate video game exposure with academic performance. Rather than cite some study to which the average student cannot relate, we used a spreadsheet program to calculate the correlation coefficient and its associated p value for students. Using personalized data really brings what can be "dry" material to life for students because it is their data. At the same time it allows instructors to cover higher-level concepts. Finally, the student gets practice using a tool to calculate an important statistic to interpret. At the end of class, the student can "take away" the data set and have something for further study or reference as desired.

In-Class Group Projects

Laptops can also make in-class group projects or presentations more efficient and effective. Many phenomena are explained by different, competing theories. Since each student has a laptop, instructors can divide the class into groups and assign each group to prepare a five-minute presentation covering a theoretical perspective. Studies of several different technology-integrated classrooms revealed two main findings: Group work with technology available

■ increased the amount of information available to individual students due to inter- and intra-group sharing and

■ enhanced critical thinking because the group members have to learn how to sift through conflicting information and ideas from several different sources.[6]

Students can use the presentation software on their laptops to create a brief for the rest of the class. After sufficient preparation time, the groups can "deposit" their presentation in the digital drop box (or save them to a disk) so that it can be displayed on screen during the presentation. This technique allows students to create a detailed study of the theoretical perspective assigned, get a presentation on the other theoretical approaches presented by the other groups, practice public speaking skills, and take away electronic copies of all the presentations created by their classmates.

Studies have shown that students who design and present electronic multimedia presentations tend to remember longer and understand better the concepts that they presented.[7] We wanted to know if student use of laptops in class would also help them remember longer and better understand the concepts. Our findings are discussed below.

Results

We assessed students' performance using in-class exams. Students of instructors who integrated laptop computers into their classroom strategies (the experimental group) scored significantly higher on all six exams and the final exam than students of instructors who used traditional instructional and note-taking methods (the control group). For example, the average score on exams of students whose instructors used laptops in the classroom was 86.8 percent, while the average score on exams of students whose instructors who did not use laptops in the classroom was 83.5 percent. This difference was statistically significant (p < .05).

We assessed students' attitudes through end-of-course surveys, categorizing the 42 questions into one of the three dimensions examined in this study: student motivation and interest, instructor efficiency, and student learning. Nine of the 15 questions related to student motivation and interest (60 percent) were rated significantly more favorable (p < .05) in the technology sections. For example, on a Likert-type scale that ranged from 1 (strongly disagree) to 5 (strongly agree), students in the technology sections rated instructors significantly higher on the following question categorized under student motivation: "My instructor was enthusiastic and energetic when presenting course material."

A similar trend in favor of the technology sections was also evident in 3 of the 5 questions related to teaching efficiency, such as "The homework assignments, papers, and projects could be completed within the time guideline of two hours preparation for each class," and in 9 of the 22 questions (39 percent) related to student learning, such as "In this course, my critical thinking ability increased." Overall, students in the technology sections rated questions on the survey more favorably than the traditional sections, and 21 of the 42 questions (50 percent) were statistically significant (p < .05).

We also included two open-ended questions on the end-of-course survey: "What did you like about using your laptop in class?" and "What did you dislike about using your laptop in class?" We took all responses to these questions and categorized the common responses.

For "What did you like about using your laptop in class?" the comments fell into two main categories. Of the students that used laptops in class, 73 percent made comments that fell into the category of ease in note-taking or ease of organizing and reading their notes. These comments highlight the efficiency aspect of taking notes in class. Sample comments included,

■ "Typing is a faster, more efficient way of note-taking."

■ "I could take notes faster and keep my stuff organized."

■ "I had all my notes (on laptop) and could add to them when I felt appropriate, and they were kept very neat, organized, and readable on the computer. In a notebook, they possibly would have been lost or neglected, or less legible and organized."

■ "I did not have to shuffle through papers. All I had to do was hit page up or page down and I had the information I needed. It was also

neater than my handwriting, so I could read it easier and faster."

- "It is faster, neater, and more efficient in taking notes."

Twenty-four percent mentioned other uses of the laptop, such as for computer and Internet exercises to include Web sites, CD-ROM exercises, and games. These comments highlight the motivational aspect of using laptops for classroom activities. Sample comments included,

- "I like some of the experiments that we did on the CD in class."
- "We were able to access various websites and tests that related to the material."
- "I liked the group time when we used the computer to type things down and then present them in class … It was a VERY effective learning tool."
- "It allowed us to use simulations to do different experiments during class."
- "I liked using my laptop because we could use the Internet to look at simulations relating to the course material."

For "What did you dislike about using your laptop in class?" the comments also fell into two main categories. Fifty percent of those students who used the laptop did not like carrying it back and forth to class, mainly because they felt it was heavy and cumbersome. Sample comments included,

- "Pain to carry to class."
- "Bulky to carry around."
- "Lugging it around from class to class."
- "Carrying the laptop is always a chore."
- "I dislike the fact that we had to haul the laptops to class. I hate carrying my laptop around."

Thirty-two percent of students who chose not to use the laptop made comments that fell into the category of learning style and typing skills. These students preferred to take notes with pen and paper because they

- did not know how to type;
- did not like the fact that they could not star, draw arrows to, or make notes in the margins, or

> **Students of instructors who integrated laptop computers into their classroom strategies scored significantly higher on all six exams and the final exam than students of instructors who used traditional instructional and note-taking methods.**

- felt they learned better by writing notes by hand.
  Sample comments included,
- "I feel as if I learn better by writing things down as opposed to typing them. It is hard to enter charts and graphs into the laptop with efficiency."
- "I found it much easier to add notes to the margins and maneuver through the course guide in paper format."
- "Sometimes I could not type fast enough to take notes in class."
- "It takes me longer to type than write and sometimes it's easier to draw diagrams than write something out in words."

Lessons Learned

Here we highlight some of the practical aspects of using laptops in class. Specifically, we discuss classroom management techniques and several dangers and pitfalls we uncovered through experience.

Classroom Management Techniques

Establishing specific policies for laptop use in the classroom minimizes disruptions and maximizes efficiency.

Batteries Only—No Cords. With a classroom full of computers, battery power is a must. If each student had to plug in a laptop, the subsequent tangle of cords would make accidents inevitable. Therefore, battery life is an important consideration when thinking about using laptops in the classroom. The laptops that our students use hold two batteries with a life of between five to eight hours; however, this is not the case with all laptops. Students and universities must take this into consideration when determining which laptops to use. Even with a long battery life in our class laptops, we still had the occasional student who came to class with dead batteries. We treated this situation the same way we would have if the student came to class without a writing instrument, textbook, or notebook.

Editable, Electronic Syllabus. Providing an editable, electronic version of the class syllabus will allow students to do their before-class preparation and in-class note-taking as described above.

Screens Down During Movies. Require students to put their laptop screens down during in-class video movies so that they don't interfere with another student's ability to focus on the screen and so that they "get" what you intended during the film.

"No Outside Work in Class" Policy. Occasionally, students will try to complete requirements for another course during class time. Wireless access to the Internet and network folders on the laptop merely provide a new means to try this. Don't be afraid to tactfully address violators. A direct but tactful request is generally all it takes to get students back on track. Circulating around the classroom also makes students aware that you see what they are looking at on their screens.

"Classroom Rules." We find that most students want to do the right thing most of the time. Publishing or otherwise providing a list of norms will ensure that your students know what is and what is not allowed in class.

Dangers and Pitfalls

Students and instructors face sometimes unexpected hazards in using laptops in the classroom. A few of the more obvious ones follow.

Surfing the Web. Initially, students surfing the Web in class poses the biggest challenge to using laptops. Fortunately, Web surfing is easy to spot because students are decisively engaged with the computer, but not much keyboard activity is involved. Again, a direct but tactful request or walking around the classroom is generally all it takes to get students back on track.

Instant Messaging. Also a big challenge during the first couple of classes, instant messaging is more difficult to detect because it does resemble taking notes. By moving around the class and behind the students, you will keep most students on track. Another technique is to look at which programs or applications are active and which ones have been minimized. Again, a direct but tactful request is generally all it takes to refocus students on class goals.

Legitimacy of Web Sites. Using the Internet is one way to spark interest in your topic, but students must not leave class thinking that every Web site visited in class is "scholarly." For example, one Web site offers an applet to help students determine the "sex" of their brain. While useful for generating classroom discussion, that Web applet should not be confused for a scholarly resource. Other sites have similar credibility issues.

A Computer Exercise for Everything. The laptop is a tool the instructor can use to facilitate learning, but it should never become the focus of the class. Some topics are better covered in small-group discussions, while others are better brought to life with role-playing techniques such as skits. Sometimes the laptop is not the best teaching and learning tool. The key is to use the most appropriate medium

for the material to be covered. The CEO Forum on Education and Technology put it nicely when they concluded from a review of studies that "technology can have the greatest impact when integrated into the curriculum to achieve clear, measurable educational objectives."[8]

Instructor Preparation. Integrating wireless laptop technology requires instructors to learn a new set of skills to be effective. As mentioned earlier, first and foremost, instructors must have a laptop if they are expected to integrate it into classroom practices. Additionally, instructors who see and experience the effective strategies and techniques for integrating laptops into classroom practices will be much more confident and likely to integrate laptops into their classrooms.

At the beginning of a summer training session in which we taught four new instructors, one of the questions we asked them on a survey was, "To what extent do you feel prepared to integrate laptop computers into classroom activities?" On a 5-point scale ranging from a "1" of "Not Ready!" to a "5" of "Ready to go!" the average response was 2.25. At the end of the training, the average response to the same question was 4.5—a significant positive change ($p < .001$).

Faculty who had been teaching several years also changed some of their methodology once they learned about the effectiveness of laptops in the classroom. When the four instructors in this study modeled several typical lessons during faculty workshops for other faculty who were using more traditional methods of teaching, many quickly started integrating technology into their own classes. Having a server to share strategies and techniques also facilitated faculty integration. Thus, if you "show and tell" faculty how to integrate the technology and provide them with sample lesson plans, they will be much more likely to leverage this new tool to facilitate learning in their classrooms.

Discussion

For the teacher, the "simulated" laptop environment created in the computer lab was functionally no different from the "hi-tech" classroom; it achieved the same tasks in a slightly different but no more onerous or simple manner. Let's take, for example, the steps required to "beam" a student's answer over the classroom projector onto the screen for all to view. In the hi-tech classroom, the student would log onto the course's Blackboard page, go to the digital drop box, and post the document for the instructor to access. In the computer lab the student had to open the folder on his hard drive that held the document, open the turn-in folder, and copy the document for the instructor to access.

There are some practical differences, however. Laptops offer a more intimate, personal atmosphere in the classroom, not present with the towers and fixed stations of a computer lab. Also, in most classrooms the laptop gives the teacher more flexibility in the configuration. If the teacher would like to switch around how desks are arranged or put the students into groups, laptops make this much more feasible than does a computer lab classroom.

Lastly, during some class activities the teacher might not want the students engaged with or distracted by computers in the class. With the laptop computer the instructor can simply say, "Screens down, everyone. Close your laptops for the next five minutes of class." This is not an option at computer stations. For the student, the biggest difference between a computer lab and using his or her own laptop computer is mobility. When class is over, all activities, presentations, and notes will leave with the student on the laptop. In the computer lab, the students must access their notes via a shared drive.

Our integration of laptop technology into this general psychology course seemed to have a positive influence on student learning and student attitudes toward the course content.

We found that these techniques

■ increased the students' motivation,
■ added efficiency to the classroom in both note-taking and amount of material covered, and
■ seemed to increase student learning, as supported by the higher test scores of those students in the laptop versus no-laptop classrooms.

Middleton and Murray also found that math students of teachers who were "high-level users" of technology in the classroom scored significantly higher than students of teachers who were "low-level users."[9]

Another possible explanation for the results of this study is linked to the instructors themselves. Though all instructors who teach this course receive the same teacher training and have nearly identical educational backgrounds and similar teaching experience, the four instructors in the experimental group might simply be more effective instructors than the control group. Because these instructors were self-selected, they were obviously motivated to make the technology work. Their motivation alone might have directly influenced the students' preparation and performance on the exams as well as their more favorable ratings on the end-of-course survey. Whether the laptop technology or the motivated teachers prompted the positive results, laptop computers are coming to the classroom. This increasingly prevalent technology can be a benefit for the teacher and the learner—or a distraction. Results will depend on how the technology is implemented.

Using laptop computers in the classroom also promotes computer literacy for life-long learning. The common assumption is that today's college freshmen are computer literate. We found that they are great typists who are very good at using the Internet, instant messaging, and playing games. Many of them are not very good at using the software applications most useful for schoolwork. Using computers in class "encourages" them to learn how to effectively use the tools that they will likely be using the rest of their college years and beyond.

Research supports the contention that technology infused into the classroom increases student expertise in work-force skills.[10] Even the most basic use—having students take notes on their computers—has been shown to help high school graduates improve their proficiency at accessing, evaluating, and communicating information[11]—a skill essential in many careers.

We have shared several useful techniques for bringing learning to life and for providing efficient and effective feedback in the classroom that we discovered after one semester of integrating laptops in a psychology course. Employing the laptop computer in the classroom is not all easy. It is, in fact, work. Often this means revising nearly all your lesson plans and thinking about your topic in fresh, innovative ways. Members of the faculty have provided mixed reviews on the use of laptops in class. Most teachers who tried employing the techniques discussed in this article had positive comments. For example, one faculty member stated,

> Although some students learn better from a hard-copy course guide [syllabus], overall I think the computers enhance the classroom experience. I actually see students adding my comments to their notes—sometimes in a different color. I have also mentioned things in class and said "when you get the chance, look this up on the Web" and have had students immediately check it out and validate what I had mentioned.

One concern among teachers, however, has been the possible loss of eye contact. Several faculty members feel that the students may spend more time looking at their screens than looking at the instructor. While this might be true of some students, we found no change in the amount of eye contact between students and teacher. In fact, some of our students could maintain eye contact while taking notes because they can type without looking at the screen or keys (which is something most people cannot do with paper and pencil).

The majority of teachers exposed to methods of using the laptop in the classroom employ the techniques we have described. One senior faculty member who has taught using everything from notes on the blackboard to an overhead projector with transparencies to PowerPoint slides is now using laptops in his classroom. He explained,

> [Laptops] are efficient and effective in the classroom. I am excited when my students get excited and show me on their laptops the neat Web sites, clips, or games that they have found related to concepts in class. Also, my students are now taking their laptops, with their class notes and files, with them on trips off campus that are associated with their extracurricular activities.

As discussed, there are dangers and pitfalls that can only be avoided by using different classroom management techniques. However, it has been our experience that integrating laptops truly enhances the efficiency and effectiveness of teaching and learning. These benefits far outweigh the costs of learning to integrate the laptop technology. We hope our article will aid you in using the "miracle" aspects of technology and avoiding the "menace" aspects in your classroom learning environments. *e*

Endnotes

1. T. D. Cook and D. T. Campbell defined quasi-experimental studies as "Experiments that have treatments, outcome measures, and experimental units, but do not use random assignment to create the comparison from which treatment-caused changes is inferred." See their book Quasi-Experimentation: Design & Analysis Issues for Field Settings (Boston, Mass.: Houghton Mifflin Company, 1979).

2. B. Means et al., Using Technology to Support Education Reform (Washington, D.C.: U.S. Department of Education, Office of Educational Research and Improvement, September 1993); <http://www.ed.gov/pubs/EdReform

Studies/TechReforms/> (retrieved May 25, 2004).

3. H. Wenglinsky, Does It Compute? The Relationship Between Educational Technology and Student Achievement in Mathematics (Princeton, N.J.: Educational Testing Service, Policy Information Center, 1998); <ftp://ftp.ets.org/pub/res/technolog.pdf> (retrieved May 25, 2004).

4. F. J. Boster et al., A Report on the Effect of the Unitedstreaming Application on Educational Performance (Farmville, Va.: Longwood University, 2002).

5. Each college or university should check with their audio-visual department concerning fair-use copyright laws and agreements.

6. See S. Lafer and A. Markert, "Authentic Learning Situations and the Potential of Lego TC Logo," Computers in Schools, Vol. 11, No. 1, 1994, pp. 79–94; H. McLellan, "Interactions of Student Partners in a High School Astronomy Computer Lab," Computers in Schools, Vol. 11, No. 1, 1994, pp. 29–41; D. Newman, "Computer Networks: Opportunities or Obstacles?" in Technology and Education Reform: The Reality Behind the Promise, B. Means, ed. (San Fran-

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