

Teaching with Technology: May You Live in Interesting Times

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Abstract:

During the last ten years, teaching with computer technology has diffused extensively throughout undergraduate economic education. This paper reviews the literature on the implications for student learning, presents specific educational activities that use a number of different computer technologies, and discusses several growing problems such as "cyber-plagiarism" along with some current solutions to these problems. But, there are many more opportunities than potential problems. The paper concludes with some of the latest computer uses and presents possibilities for the future.

Teaching with Technology: May You Live in Interesting Times

We've always taught with technology, perhaps initially with sticks in the sand or colored paint on the cave walls. Then, as today, the goal of using technology was almost certainly to explain more effectively. Has the teaching profession (economics instructors in particular) moved quickly to adopt new instructional technologies? An illustrative story about the classroom was presented about ten years ago by Eric Feder of the Colorado Department of Education (Griggs, 1995; see Sosin, 1998). Picture Rip Van Winkle waking in the mid-1990s from a century-long sleep. If he awakened in a doctor's office, he'd look around and have no idea where he was. If he awakened on an airplane, he'd be terrified. But if he woke up in a classroom, he would know exactly where he was and feel quite at home.

If our Rip Van Winkle opened his eyes today, about ten years later than in the original story, would he recognize the classroom? Of course he would, but it is also true that much has happened in the economics classroom in the last 10 years. The use of computers, data projectors, PowerPoint, electronic games, and recently wireless handhelds and tablet PCs have changed the face of the some classrooms.¹ Has it also changed the way we teach? In this paper, we discuss technological developments in the classroom, briefly consider recent research on the impact on student learning of technology use in economic education, and then discuss some teaching activities that take advantage of computer technology.

In the 2003 "Back to School" issue of *PC Magazine*, Metz points out that "on-campus wireless networks have doubled every year for the past three years," and, for the U.S., "more than 90 percent of all public universities run some sort of wireless LAN" (Metz, 2003 p. 91). Today's well-dressed college student has a computer and that computer is often a notebook with

wireless connectivity. College students today clearly expect the computer to be an important learning tool.

How can economic educators can take advantage of rising student expectations about using computers to learn? Economists had extensive access to computers and the web as early as 1996 (Sosin, 1997), and a 1999-2000 survey of some department members in nearly 100 universities showed that both email and the web were used by all but a few economics instructors (Blecha, 2001).² Using computer technology to help teach economics is no longer a novelty. Computers are just one more basic tool in the economics instructor's toolkit. Although most economics instructors have adopted these two basic electronic technologies into their teaching, they have been reluctant to adopt more complex computer-based activities or other teaching innovations such as active learning techniques (Becker and Watts, 1996, Becker, 2004). Using a logistic regression model and a hazard model, Blecha related this reluctance to levels of investment of human capital in existing teaching techniques. Some experienced professors, e.g., those with investments in transparencies or lecture notes for the black/whiteboard, might view the Internet and perhaps even computers as *new* technology, but what do students think? For 18 year-old freshmen, personal computers have been around for their entire lifetimes and the Internet has existed for over half of their lifetimes.³

Widespread use of computers to teach economics to undergraduates might be appropriate for several reasons, but two questions are very important: first, is there evidence that using computing improves teaching on either cognitive or affective measures, and second, if an instructor decides to use more elaborate technology than email and websites, what is a reasonable personal cost?

We next review the research and scholarly discourse on using computer technologies and then provide some teaching vignettes using electronic technology that could be used in various

courses. We also provide some sources for additional computer activities and discuss security and cheating issues.

I. USING TECHNOLOGY IN TEACHING: VIEWPOINTS AND RESEARCH

Are current advances in educational uses of computer technology a giant step forward for education? Will technology help instructors be more effective and efficient at their jobs, and will their roles change significantly? At one end of the spectrum of viewpoints is James Burke, the British television host of “Connections,” the acclaimed program on the evolution of technology. In a keynote speech in 1996, Burke claimed that “the next fifty years are going to make everything that went before it look like ‘See Spot Run.’ ” (Thomas, 1996, p. 16). He believed that newspapers, books, and television sets would be replaced by the web (or its successors) and that the machines that connect us to networks would be wireless, portable flat-screen pages that are voice-responsive. If Burke was right, handheld computers and PDAs would be used by students as well as teachers to demonstrate economic principles and conduct economics experiments. This is already happening in a few undergraduate economics classes, particularly for teaching with economics games.

At the other extreme are dissenters such as computer scientist Clifford Stoll, who asks if computers are a way to avoid learning, which is hard work, rather than a new way to learn (Stoll, 1995; also see O’Neil, 1996). Stoll is concerned that the use of computers in education jeopardizes the position of instructors as the central source of information, reduces students’ attention spans, and inhibits development of their writing abilities. Likewise, Talbott (1995, p. 347) foresees the dangers of a technologically networked society: “It is not that society and culture are managing to assimilate technology. Rather, technology is swallowing culture.”

Computer technology may or may not provide the next important advance in learning methods, but students are increasingly ready to use it in economic education and expect it to be a

part of their college experience. College students adopt technology early and use the Internet heavily according to the Pew Internet and American Life Project survey of college students. (Jones, 2002). The Pew survey found that by the time they were 16 to 18 years old, almost all current U.S. college students had used computers and 86 percent had gone online. Four-fifths of the students reported that Internet use had a positive effect on their academic experience. Even more telling, a Pew survey of U.S. high school students in 2002 found that students are less likely to be satisfied with conventional approaches to teaching and learning and prefer that instructors use the Internet more actively and productively in assignments (Levin and Arafeh, 2002).⁴

As more economics instructors develop experience with technology and Internet teaching, a key issue is how the use of technology affects student performance. Results from studies about using the Internet in economics classes are mixed. In some cases, enhanced learning is attributed primarily to improved instructor-student communications (Agarwal and Day, 1998; Manning, 1996). Agarwal and Day used standardized test scores and final grades to compare control and treatment classes, concluding that the Internet has a positive influence on learning, attitude towards economics, and student perception of instructor effectiveness. Leuthold (1998) reported that 65 percent of the students in introductory economics agreed or strongly agreed that being able to utilize the web helped them understand the concepts, 86 percent felt the web increased or somewhat increased their learning and 66 percent reported increased motivation. Attendance in her technology classes was as high or higher than in a traditional class.⁵ In an article reviewing the literature on using computers in economics classes, Grimes and Ray (1993) conclude that computerized tutorials and simulations were shown to enhance student learning and perhaps to improve attitudes towards economic.

In a panel study that included data collected from 30 principles instructors and their students at 15 schools, Sosin, Blecha, Agarwal, Bartlett, and Daniel (2004) found that students in technology-using classes have a small but statistically significant performance advantage over students in classes using little technology. They also found that some technology activities contribute to learning and others do not. Most interesting are results for individual types of technology. For example, PowerPoint, when used as “PowerPoint and talk,” to replace traditional chalk and talk, had a negative effect on student performance, but using courseware had positive effects in macro classes and emailing technology materials had positive effects in micro classes. The study showed that even instructors who identify themselves as low-technology users were using some types of computer technology in their teaching. Preliminary time cost results from this study are that experienced technology and non-technology instructors spend about the same total amount of time preparing for classes; however, the incidence and activities that occupy their time differ. For example, the technology instructors spend more of this time preparing on evenings and weekends than the instructors who use less technology. They also spend more time constructing exams and less time grading them because of online web grading.

Other recent studies are neutral or negative with respect to student learning from technology-enhanced courses. Terry, Lewer, and Macy (2003) compared a strictly online course, a blended or hybrid course (with some classroom time replaced by online time), and a strictly classroom course. Controlling for student ability, effort, and demographic characteristics, they found that the online course students scored significantly lower than the classroom students. The hybrid course students scored lower also, but this difference was not significant.

Entirely online courses did not fare well in recent comparisons of student learning. Coates and Humphreys’ (2003) survey of institutions revealed that many economics departments are now

offering introductory economics entirely online. They also reported that active learning pedagogy is more prevalent in the online than in the face-to-face classes, although some courses offered online merely simulate lecturing. A significant negative effect measuring from three to six of 33 TUCE questions from students in the online courses compared to traditional classes was found in three universities after controlling for the self-selection effect of students choosing the type of course in which to enroll (Coates *et. al.* 2004).

What of the suggestion that it isn't the technology that matters in online courses, but the use of active learning and other sound teaching techniques? The current evidence suggests that students do less well in online courses that simulate the typical in-class economic lecture classroom. For example, the instructors in the Brown and Liedholm (2002) experiment used streaming videos of the in-class lectures and activities for the online classes. They concluded that students learned better in the classroom course. In another study, Brown and Liedholm (2004) presented students with a variety of learning tools for online use. The students, given choices of tools, elected to use a range of learning tools (e.g. textbook, Excel worksheets, practice quizzes, lecture videos) and displayed a wide variety of learning strategies. Students were positive about the course and about their learning and performance. Brown and Liedholm concluded that the hybrid course offers more promise than strictly online or strictly classroom because a wider variety of learning tools can be presented while retaining face-to-face contact and lectures. It will be interesting to see performance results from an active learning class that uses many learning tools. Another variation on using technology in ways that don't replicate chalk and talk is "mastery learning." A student works on a given topic and cannot advance to the next until that topic is mastered (Myers, 2004). The student may have a selection of tools to help him or her learn the economics material and wide latitude to customize the selection.

Will future college students be more accustomed to and likely to expect Internet and computer mediated/assisted lessons? If computers and the web are increasingly popular ways to deal with information in the future, it is almost certainly the way students will expect to find and learn information in school. High school students in the U.S. overwhelmingly use electronic technology and expect their instructors to make productive use of it (Levin and Arafeh, 2002). Some high schools that cannot afford to provide computers for all students are introducing handhelds (PDAs), so these students will be entering college with very sophisticated knowledge of using handheld computers. Colleges will seem out of date, both technologically and culturally, if they do otherwise, resulting in the so-called “digital disconnect” between student expectations and teaching methods. Given the inevitable use of more technology, the appropriate question is not “Do students learn better when taught with technology?” but “How can instructors ensure that students learn well when taught with technology?” A key task will be to incorporate active learning by appropriate use of electronic technology in economics courses. Simkins (1999), Rycroft (1999, 2001), Greenlaw and Deloach (2003), and Schmidt (2003) provided examples of ways to incorporate active learning using computer technology.

As the use of computer technology in education matures, the focus turns from questioning the overall use of computers to asking how the technology is used and which types of technology are most appropriate for which teaching approaches and concepts. The following pages offer some specific good practices for teaching with technology.

II. USING COMPUTERS AND THE INTERNET TO TEACH ECONOMICS

The familiar tools of technology—email, web assignments, computer games, course management software, mailing lists, bulletin boards, and multimedia—can be productively and easily used to teach economics at a relatively low cost in instructors.

Email

Simple uses of email are hardly an innovative means of communication with students today; the obvious uses include one-on-one dialogs on course policies or topics and bulk email to the class with assignments.

Another use of email, a variant of “just-in-time-teaching,” is described below. Based on what happens in one class session, email is used to send assignments to the class for the next meeting. If a particular point covered in the last class is unclear to some or many students, additional work can be given for the next class. On the other hand, if the material in a class meeting seems to be widely understood, email questions can be focused on new topics for the next meeting.

Although simple, just-in-time email illustrates how technology can be used as more than a substitute for traditional means of communication.

Goffe created an active learning activity that can be used in a large or small class by combining the convenience of just-in-time email with the one-minute paper, an active learning activity that has been shown to be effective for student learning (Chizmar and Ostrosky 1998). The basic idea of the one-minute paper is that the instructor asks the students to write a key point and/or a question or comment about a key point for that class meeting. Here are the steps to conduct this activity:

1. Develop a randomized list of your students email addresses. Select a subset of the class to email; ideally the number should be such that each student is emailed a significant number of times during the semester. Randomizing a list of email addresses can be done in Excel or a statistical package, although absolute randomization is not critical.
2. After class, email to the selected addresses one simple question, “What was unclear to you today in class?” The Chizmar and Ostrosky technique also asks “What is the most important thing you learned today?” Goffe uses one question to make the process even

simpler. The student is asked to answer the question by email. However, the effect of one versus two questions and the use of email on student learning is unknown.

3. The students reply to the email describing the material that they find confusing.
4. The students' questions, along with the answers, are shared at the beginning of the next class by the instructor without revealing which students responded. Or, email could be sent to the entire class with the questions and responses (again, the questions and answers have identifying information removed).

This method serves several purposes – it gives the instructor feedback (which is often difficult to obtain outside exams), gives students incentives to look back over the material and test their understanding, and other students can learn when the instructor addresses the lack of understanding of their peers.

Web Assignments

Users of the World Wide Web are so accustomed to the plethora of information and the ease of finding materials that they forget how much more time and effort went into searching for information only a few years ago. Surveys mentioned earlier show that many instructors now use the web in class assignments. Even the simplest assignments, where students are asked to visit a particular website and simply report back on what they find, bring current real world information into the classroom. As opposed to imaginary widgets, a common example, the web easily lets instructors bring a multitude of actual resources into the classroom.

Although many students are quite adept at web searching, other students will need assistance to be efficient and productive. A complete lesson is available online to teach this important skill (Ferrarini, 2002), with one section for instructors to use and another for students. Ferrarini also provides guidelines on how to cite Internet resources

<<http://www.nmu.edu/economics/ferrarini/eis/intro.htm>>. The American Psychological

Association and other style guides are online for electronic media. The APA style.org guide for electronic references is located at <<http://www.apastyle.org/elecref.html>>, the corresponding MLA guide is at <http://www.mla.org/style_faq4>, and the Columbia Guide to Online Style is found at <<http://www.columbia.edu/cu/cup/cgos/basic.html>>. Finally, many students may require instruction on how to evaluate Internet resources. In addition to Ferrarini's work, the Johns Hopkins University Library has an excellent evaluation page online <<http://www.library.jhu.edu/elp/useit/evaluate/>>. This Internet resources evaluation site emphasizes using authorship, publishing body, point of view or bias, referral to other sources, verifiability, and currency to evaluate a web page. The section "How to distinguish propaganda, misinformation and disinformation" has guidelines that all students should know!

In principles classes, instructors often have students find data and perform simple analyses. For example, to introduce a discussion of oil price shocks, students might be asked to go to the St. Louis Federal Reserve Bank FRED II database, <<http://research.stlouisfed.org/fred2/series/OILPRICE/1/Max>>, to get the price of oil (specifically, the "spot" price of "West Texas and Intermediate") for the last 50 years. Students could be asked to prepare to answer questions including

- a. What happened to the price of oil in the 1970s?
- b. What happened to the price of oil in the late 1990s?
- c. What happened to the price of oil over the last year or so?

After calling on students at random to discuss these questions, the instructor can easily turn the classroom conversation to deeper ideas. For example, the instructor might extend the discussion to the impact of oil shocks in the aggregate supply and demand model, and then go on to analyze their impact on economic performance in the 1970s and the relevance of these events today.

Additional possible activities on the web. There are many interesting teaching activities described in some detail on the web. Here are brief descriptions and addresses of a few that combine technology enhancements with active learning. Web addresses to additional activities are provided in the Appendix table.

1. A National Science Foundation project by Scott Simkins and Mark Maier is developing “just-in-time teaching” (JiTT) for the economics curriculum. The basic idea of JiTT is to develop plans for class based on student feedback just before the class meets. Students submit assigned web-based exercises electronically before class. Instructors use the responses to inform the classroom discussion. The project has a useful website at <http://www.ncat.edu/~simkinss/jittecon/jittintro.html>. Marcelo Clerici-Arias also has a thorough description of how to use JiTT at <http://jitt.stanford.edu/Documents/Paper.pdf> . A modified version of JiTT known as the “just-in-time syllabus,” by Raman, Shackelford, and Sosin, is described with examples at <http://ecedweb.unomaha.edu/jits.htm>.
2. "Integrating Web-Based Student Competitions into Principles Courses," by KimMarie McGoldrick and Peter Schuhmann is both a paper and a website at <http://www.uncw.edu/cte/et/articles/Schuhmann/>. This activity extends the excitement of inter-university sports competitions to learning economics. The authors describe a web-based method where students compete between campuses based on their economic knowledge.
3. An interesting use of technology to dramatically change a class structure is found in "The Inverted Classroom" by Platt and Lage (2000) of Miami University of Ohio. Their approach is to create an inverted classroom in which the lectures take place outside of class via technology, and all classroom activities are discussion, experiments, and other active learning activities.

Computer Games and Simulations

Computer games that teach market dynamics are increasingly popular. Games are available in electronic form for in-class use and in web form to be played online. Several sources of online games are Murphy (2004), Aplia <<http://www.aplia.com>>, and Holt's Vecon lab <<http://www.people.virginia.edu/~cah2k/programs.html>>. Murphy provides a step-by-step description on the web for how to play the double auction game that is popular in principles classes. He also provides downloadable Excel spreadsheets that can be used in class to display the bids and create the supply and demand schedules. The commercial Aplia website keys online games to teaching specific economics concepts.

Holt offers an amazing variety of free online experiments for economics students. His Vecon Lab contains some 35 interactive experiments. A full set of instructions for instructors is located on the guide page at <<http://veconlab.econ.virginia.edu/guide.htm>>. The link "Online Demonstration for a Traveler's Dilemma" is a demo available at any time and does not require any advanced setup. Also, in links from this guide page, Holt provides pedagogical ideas about which games to choose and provides detailed instruction on how to test them and use them to teach economics. Students login from a browser or even a hand-held PC with a wireless card using the instructor-provided session name. The most used game on Vecon Lab is the double auction.

Course Management Software

In what has become the easiest way to create a variety of instructional content on the web, many campuses are now moving to course management software (CMS), which provides all manner of course support: from content to grade recording and reporting. Widely used commercial examples of CMS are WebCT and Blackboard, but some schools have developed their own.⁶ These web-based software packages are typically purchased by the college or university and

placed on servers managed by the school's IT department for the entire campus. Over time, this encourages faculty and students to become quite proficient because a common interface is presented by all courses and subject areas. Instructors also find CMS very easy to use and powerful. CMS can be integrated with the campus registration and enrollment software, so that for each course offered, a basic website is created providing class lists of students and their email addresses. In some schools, even student ID photos are available to instructors.

Documents of all kinds (Word, PowerPoint, etc.) can easily be uploaded to the course website and made available to students. In some cases, copyright issues are involved, as discussed later. The instructor's class notes and students' background readings for the next class can be provided on a just-in-time basis. A communications section provides email for individual students, small groups or all students, as well as a discussion board, chat rooms, forums, and sites for group or team collaboration. A digital dropbox provides an easy way to send a file to one or more students, and for students to send a file to the instructor. Quizzes and exams can be set up via the CMS, and grades entered and overall scores calculated. Students appreciate the grade book feature because they can see a grade as soon as it is entered by the instructor, review their grade history, and check their average at any point in the semester. Each student also has a web page for class information or personal information such as hobbies or work experience.

A relatively new commercial website for economics is an online complete course management system. Aplia <<http://www.aplia.com>> provides materials, management, and teaching assistance in the form of problem sets, tutorials, experiments, grading and tracking homework. Although this is not a free site, there are free demos on the Aplia website for review.

Some of the most exciting work being done for course management is the Open Knowledge Initiative from MIT, which is used to create learning management systems (LMS).⁷ The LMS are enterprise systems in that they are integrated throughout an educational institution or

enterprise. The idea is for universities to collaborate to produce an open and extensible software structure with common rules and standards so that the components of various educational software can communicate with each other, enabling universities to share software innovations. Such software would work with traditional university educational software and CMS systems, and encourages innovations within the same infrastructure. It also allows institutions to avoid being locked into systems from a commercial vendor, which can be a disadvantage if that vendor's pricing or update policy changes.

Modules can be developed using courseware to create an online course that takes advantage of many sophisticated tools. For example, Ed Day set up his hybrid (though mostly online) course at University of Texas Dallas using modules to teach concepts. Within each module, in addition to completing the self-test and quizzes, students participate in an online WebCT discussion forum. For example, in a module teaching "inflation," students go to the CIA fact book <<http://www.cia.gov/cia/publications/factbook/index.html>> and select one country from each of the six temperate continents. Students are asked to find the rate of growth of real output in several countries and the inflation rate, then construct a table showing this information. The student posts the table and makes observations about growth, inflation, and a possible relationship between them. on the forum, and each student reads the postings of three other students, commenting on at least one. Other modules contain a series of discussion questions or other activities for the forum postings.

Using Blogs for Teaching Economics

Blogs (web logs) are relatively new to the Internet. They can be seen as the successor to the home page craze of the 1990s. Instead of a static web page, over time their authors log their views, observations, opinions, and experiences on almost any imaginable subject. In short, those sites become a public journal, many also allow readers to post comments. Blogs frequently

quote other blogs, and often become public debates (not unlike a bulletin board). Blogs vary dramatically in quality and general interest. Many are juvenile, but some are quite professional. Some well-known journalists write blogs, which has led to interesting issues. There are many scholarly blogs as well, but their ultimate effect is unclear. As Glenn (2003) asked, “Is this a revolution in academic discourse, or is it CB radio?”

Blogs can be used several ways in economics classes. The first is for students to maintain their own blog about the course. This could include topics such as insights, areas of confusion, and commentary on the course. Another is for the instructor to run a class blog, perhaps starting some discussion topics for student comment. The third use is for students to read and comment on blogs pertaining to economics from outside the course. Students should be warned that blogs “in the wild” are not intended to be objective discussions of various viewpoints. Some economics blogs are created to express the strong viewpoint of the owner, which may be a minority or even crank opinion on an economics issue. Yet, this type of viewpoint diversity could be used as an excellent opportunity for teaching critical thinking, with a clear role for the instructor in helping students evaluate, compare, and summarize. At best, blogs have the potential to “promote interactivity, provide opportunities for active learning, increase student and teacher interactions, increase higher order thinking skills and improve flexibility in teaching and learning” (Ferdig and Trammell, 2004, p 16). In short, used wisely and carefully, blogs can make the course come alive in a way few other technologies can.

A list of economics blogs can be found in the section of Resources for Economists on the Internet devoted to them: <<http://rfe.org/Blogs>>.

Build an Online Course from Existing Online Materials

In the previous sections, we have shown that building an online course or adding technology to a face-to-face course does not require instructors to have advanced web knowledge. There are

abundant and growing resources to teach most economics concepts on the web already. The most complete site for online economics resources is Resources for Economists on the Internet <<http://rfe.org>>, which describes some 1300 resources in about 100 sections and subsections. The teaching section <<http://rfe.org/Teaching>> is broken into five parts: General; Books, Textbooks and Online Notes; Miscellaneous; Research and Support; and Tutorials, Exercises, and Subject Guides.

Many web teaching resources are interactive and ready to incorporate as online active learning. A great source for these materials is the Online section of the *Journal of Economic Education*. <<http://www.indiana.edu/~econed/onlinehome.htm>> For example, Shor (2003) provided interactive tools and applets for game theory. Schenk (2003) provided an online text with interactivity for both micro and macro. Kaufman and Kaufman (2002) created interactive web graphs. Mixon and Tohamy's (2002) produced interactive cost curve tools, and Barreto (2001) made available an Excel application for teaching comparative statics. Although there are fewer web materials for macro than for microeconomics, Gartner (2001) offered a site with excellent interactive tutorials and applets for intermediate macro.

Communicating with Other Economics Instructors

Although many departments and institutions are putting an increased emphasis on teaching, it can sometimes be difficult to engage departmental colleagues in discussions about teaching. Some questions are pragmatic but nevertheless important, such as what textbooks are desirable for a newly developed or assigned course. Fortunately the Internet provides a useful tool: the *tch-econ* mailing list <<http://www.elon.edu/econ/tch-econ/>>. Our experience is that economics instructors are generous with their time when focused questions are posted. Cogent replies are forthcoming to many of the questions that seemingly can't be answered locally.

III. SECURITY AND LEGAL CONCERNS

Computer Security.

Every computer user has heard of the importance of virus scanners and firewalls, but in an academic setting, these tools may even be more important because of exam and gradebook security. As described in Kerkvliet and Sigmund (1999), cheating is common, and vulnerable computers are another possibility for the ethically challenged. It is too easy to install a “backdoor” on a computer to retrieve its contents and track every key stroke. Virus scanners should be used and updated frequently, but “firewalls” should be used as well to restrict connections between a computer and the Internet. Many break-ins exploit “open ports” left by some software; however many users do not need the offending software and should remove it. Older telnet and ftp programs, which offer an avenue for break-ins as *userid*s and *password*s travel unencrypted and are easy to capture, should be replaced with their modern counterpart, ssh (secure shell).

Plagiarism Detection and Avoidance

Some 82 percent of students admit to cheating (McCabe, Travino and Butterfield, 2001).

Although all cheating is not plagiarism, the use of the Internet is increasing the plagiarism rate because of the ease of cutting and pasting unattributed material into writing assignments, according to the Center for Academic Integrity <<http://www.academicintegrity.org>>. This is referred to as “cyber-plagiarism.” One striking example of the ease in which one can cheat was found on Google in late 2003. In a search for “macroeconomics” two of the sponsored links were for paper mills. Faculty members might choose to see what is available at such sites; one listing of them is found at

<http://dmoz.org/Reference/Education/Products_and_Services/Academic_Papers/Fee_Based/>.

Technology is a double-edged sword when it comes to plagiarism because many instructors use Google to search for odd-sounding phrases in assigned papers in order to investigate unreferenced copying. However, there are many sites that Google misses, including material Google cannot index because of password protection. Some of these websites contain information students might copy, such as paper mills, newspapers, magazine articles, and journals. Thus, some instructors turn to specialized tools, and two leading providers are EVE (Essay Verification Engine) <<http://www.canexus.com/eve/index3.shtml>> and Turnitin <<http://www.turnitin.com>>. ⁸ At Turnitin, all essays and papers submitted for checking are then added to the rapidly-growing database of materials they use to identify plagiarism in future submissions. Their database as of May, 2004 contained 4.5 billion pages. Compared to Google and standard search engines, Turnitin's search engine also downloads more complete contents of long web pages into its database; thus, plagiarized material is more likely to be found. Plagiarism of a student's paper can easily be checked, and various sources of copied material from them can be detected.

Currently, many instructors believe they can catch plagiarized papers when they spot an unusual phrase or writing not consistent with a student's previous work. But might students cheat more intelligently – might a B student buy a B paper? This conjecture is more than hypothetical because some paper mills report the grades received on their papers. Thus, software and websites like EVE and Turnitin may well catch plagiarism that is otherwise undetectable. Assigning idiosyncratic papers deters some forms of plagiarism, but Turnitin finds that less than one percent of plagiarized papers come from one source – instead, they almost always contain bits of material from different sources, and that is much harder to deter by choice of assignments. In addition, some sites that sell papers to students will also write a paper to the faculty requirements for a price. Finally, consistent use of these tools is much more

methodical and time effective than searching for the odd phrase that jumps out when grading. Check with your campus IT department because many campuses have site licenses for these or similar software. Technology has also made cheating on exams easier – the proliferation of cell phones with text messaging, PDAs, and advanced calculators has led many instructors to bar their use or even availability during exams.

IV. WHAT DOES THE FUTURE HOLD FOR TEACHING TECHNOLOGY?

It seems safe to predict that technological innovations in teaching will continue at a rapid pace. With rising bandwidth at home and at schools, the use of online video is rising and AOL is already testing video messaging (Saunders 2003). Online office hours are clearly on the horizon; Marcelo Clerici-Arias at Stanford already holds regular office hours that are captured with an electronic whiteboard and microphone, just as classes are filmed for later review at some institutions (Olsen, 2003). One advantage of filming is the ability to save the instructor's responses to questions so that students could view them at any time—a video FAQ (frequently asked questions) file. Online video is already having an impact on distance education. Presenting material in a variety of ways permits students to choose sequences of activities that best suit their learning styles, for example, some students prefer to start with online graded quizzes while others prefer to start with readings or outlines of material.

Another variation of online communication that is likely to be increasingly used in economic education is interactive software for groups working on the Internet. For example, ComLabGames <<http://www.cmu.edu/comlabgames>> lets students learn game theory with specialized software (i.e., not through a web browser) over the Internet. In some cases students can play games with other students at remote sites. Such software is similar to “massively multiplayer” games where hundreds to hundreds of thousands interact online; currently some of the leading online games are the “Sims Online” and “Ultima.” Some economics students are

playing these games now. In the future, can such software be used to simulate a market or economy with hundreds or thousands of students participating from dozens of campuses?

In addition to using technology to connect people miles or continents away, teachers and students will use innovative and connective technology right in the classroom. The use of data projectors and PowerPoint was an incremental advance over handouts, chalk, and blackboards and often just as lecture-based. However, new computer technology is being developed that will be more than a static presentation background for the classroom lecture. Three devices already being incorporated into the economics classroom have the potential to change the way we teach in the near future: wireless handheld PDAs, tablet PCs, and electronic whiteboards.

Experiments are underway with wireless handheld devices in classes to survey students and to give ungraded quizzes to test class comprehension (Homan, 2003; Syllabus Magazine, 2003). Ball (2004) and her colleagues at Virginia Tech have developed such a system for economics instruction using inexpensive wireless handhelds. With their handheld software, an instructor can use simulations to test student knowledge and reinforce concepts. In a carefully designed study, they found the use of the handhelds significantly and considerably increased learning. While they have yet to test in a very large class, it should be possible for 600 students. Other users of this technology include Holt (2003), whose economic experiments and simulations can also be run in class with handhelds.

A simpler dedicated device for classroom use, much like a TV remote, already exists. Classroom Performance System (CPS) is manufactured by eInstruction, whose marketing partners include McGraw Hill. One could easily envision using the CPS devices for other active learning techniques, like market simulations, to overcome the difficulties of coordinating and recording results in large classes. Its low cost makes it an appealing alternative to handhelds.

Electronic whiteboards allow the instructor to write or draw on a monitor in “digital ink,” with the information projected to students. More recently, wireless tablet PCs can write to electronic whiteboards or any projector that accepts wireless input. This combination opens many possibilities. Picture the instructor and students writing notes and interacting on the tablet screens of their networked wireless tablet PCs. The instructor does not have to stand at the front of the class because the computer tablet is completely mobile. He or she can walk around the classroom (or sit in the office) and write on the board, bring up previously created notes, show spreadsheet tables, draw graphs on the fly, or go to relevant websites. Group work is easy to organize via the network. On their tablets, students take notes (or bring up the instructor’s notes if provided), make annotations such as underlining or circling important points, write comments, make calculations and work with mathematical software, and collaborate on questions or projects. This future has already arrived for some. Dan Talley of Dakota State University in Madison, South Dakota and his students (all using tablet PCs) are doing much of the above in 2004.

Others have more radical views of the future of technology in education. According to Foreman (2003) and Prensky (2002), education in the future should be like an immersive video game. This might sound fantastic, but the U.S. military, with a multi-billion dollar training budget, has used such software to great effect at all ranks (Prensky 2002). Prensky argued that instructional video games would be highly suited to current students, whom he calls “digital natives.” He and others contend that digital natives have been raised on digital input and that their brains process information differently than older generations: shorter attention spans, a preference for rapid information, an ability to acquire information randomly, and love of action they can control. The massively-multiplayer Internet games might be a step in this direction. Prensky’s suggested software is similar in concept (though *very* different in speed and execution)

to teaching using novels some instructors already use, namely, the Marshall Jevons series and the Russell Roberts novels.⁹

V. CONCLUDING OBSERVATIONS

During the last ten years, teaching with computer technology has diffused extensively throughout undergraduate economic education. This paper reviews the literature on the implications for student learning, presents specific educational activities that use a number of different computer technologies, and discusses several growing problems such as “cyber-plagiarism” along with some solutions to these problems. The future of using technology for teaching economics will be continuations of recent trends: increased portability in the access to instruction and increased opportunities for interaction, including students’ interaction with the material and with the instructor and other students. There is also the possibility of radical change further down the road that may fundamentally change academia.

Appendix: Some Educational Websites of Interest.

Table 1: Selected Education Sites and Sites Useful for Teaching Materials

Website Name	Web Address
Journal of Economic Education	http://www.indiana.edu/~econed/onlinehome.htm
Resources For Economists	http://rfe.org
Amos WEB	http://www.amosweb.com
Aplia	http://www.aplia.com
Barbour's Web for tch-econ Listserv	http://www.elon.edu/econ/tch-econ/
CIA Factbook about Countries	http://www.cia.gov/cia/publications/factbook/
Distance Education, Chronicle	http://chronicle.com/indepth/distance
EcEdWeb	http://ecedweb.unomaha.edu
Economagic Economics Data	http://www.economagic.com/
Economy.com Free Lunch Data	http://www.economy.com/dismal/
Fair Use Guidelines	http://www.copyright.iupui.edu
Fair's Econometric Model	http://fairmodel.econ.yale.edu/
Federal Reserve Education Portal	http://www.federalreserveeducation.org/
Holt's Vecon Lab for Games	http://www.people.virginia.edu/~cah2k/programs.html
Hoovers Information about Companies	http://www.hoovers.com/free/
IDEAS Bibliographic Database Economics	http://ideas.repec.org/
Learning and Teaching Support Network (LTSN)	http://econltsn.ilt.bris.ac.uk
LTSN Economics – Textbook Guide	http://www.economics.ltsn.ac.uk/books/
National Bureau of Economic Research	http://www.nber.org/
Plagiarism: Turnitin	http://www.turnitin.com
Plagiarism: Essay Verification Engine	http://www.canexus.com/eve/index3.shtml
Plagiarism: University of Alberta Library Guide	http://www.library.ualberta.ca/guides/plagiarism/index.cfm
REED Database of Economic Education	http://www.cba.unl.edu/outreach/econed/reed/
St. Louis Federal Reserve FRED II, Macro Data	http://research.stlouisfed.org/fred2/
US Department of Commerce	http://www.commerce.gov/
US Department of Labor	http://www.bls.gov/
Textbook Publishers	http://www.oswego.edu/~economic/publishers.htm
ECONlinks from Simkins	http://www.ncat.edu/~simkinss/econlinks.html
Amos Web Glossary of Economics Terms	http://www.amosweb.com/gls/
Just in Time Teaching, Simkins and Maier	http://www.ncat.edu/~simkinss/jittecon/jittintro.html
Just in Time Teaching, Clerici-Arias	http://jitt.stanford.edu/Documents/Paper.pdf
Just in Time Syllabus, Raman, Shacklefold, Sosin	http://ecedweb.unomaha.edu/jits.htm
Thoughts of the Moment on Economics, and on Other Topics as Well, DeLong Blog	http://www.j-bradford-delong.net/movable_type/
Marginal Revolution, Cowen and Tabarrok Blog	http://www.marginalrevolution.com/
Argmax, John Irons	http://argmax.com/mt_blog/

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NOTES

¹ “Computer technology” in this paper will refer to the whole range of approaches that use computers and electronic technology, including spreadsheets, electronic games, Internet activities, etc.

² Betty Blecha, Economics Technology Project, 2001 unpublished manuscript; the survey results are summarized at <http://online.sfsu.edu/~bjblecha/etp.htm>.

³ In 1994, Pizza Hut installed pizza ordering on the Internet, and the first virtual bank opened. By 2003, 15 percent of all travel arrangements were booked online and one type of travel, airline ticket bookings, is considerably higher than this (Ness, 2003). Paypal is one of the largest “banks” in the world, and roughly 40 percent of banking households bank online (Dhinsa et. al., 2003).

⁴ The growth of computer use and particularly Internet use has been phenomenal over the last 20 years. Vint Cerf and Bob Kahn, the inventors of TCP (a key protocol of the Internet), used the term “Internet” in a paper over 30 years ago in 1972 (Kristula, 2001). From 1990-91, when the Internet was well known and the World Wide Web was under development by Tim Berners-Lee at CERN, to 2001, the number of Internet hosts grew from about 200 to well over 100 million (Kristula, 2001). By 2003, well over half of U.S. households were online, over half had Internet connections, and email was used each week by over 90 percent of these online households (Ness, 2003). As reported by Jones (2002), college student use of the Internet was significantly higher than that of the general population surveyed by Ness.

⁵ Much of the evidence on using technology is at the K-12 rather than the college level. Dwyer (1996) includes a list of articles that evaluate learning in K-12 schools, concluding that technology, when it is an integral part of comprehensive plan for instructional improvement, improves students’ mastery of basic skills, test scores, writing, and engagement in school. Other K-12 evidence is mixed between “improved learning” and “no significant difference,” though many studies do conclude that learning is improved. An interesting website, McREL (1997) is devoted to reporting on Internet-enhanced teaching and providing links to additional research, mostly K-12 based.

⁶ Additional information on WebCT can be found at <http://www.webct.com> and Blackboard is online at <http://www.blackboard.com>. According to the 23rd Annual Inc. 500 (10/1/2003), Blackboard Inc. is the fastest-growing privately held education company in the country.

⁷ For more information about the Open Knowledge Initiative, please see the website at <http://web.mit.edu/oki/index.html>.

⁸ Two plagiarism detection services, PlagiServe.com and EduTie.com, were alleged to have connections to three paper mills (Young, 2002). Both of them have shut down, but both now forward to MyDropBox <http://www.mydropbox.com/>. The owners admit to a connection, but report that they have now become legitimate. Additional information on this debate and links to other software and sites to detect plagiarism can be found at the software section of the “Plagiarism Resource Site, <http://plagiarism.phys.virginia.edu/links.html>.

⁹ Marshall Jevons’ economics mysteries are *Murder at the Margin, A Deadly Indifference, and Fatal Equilibrium*. Russell Roberts’ novels are *The Invisible Heart: An Economic Romance* and *The Choice: A Fable of Free Trade and Protectionism*.