Teaching with Technology: May You Live in Interesting Times

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Abstract: During the past 10 years, teaching with computer technology, such as e-mail and the Web, has become customary throughout undergraduate economic education. The authors review the literature on the implications for student learning, present specific educational activities that use a number of different computer technologies, and discuss growing problems, such as "cyber-plagiarism," along with suggesting potential solutions. The future of using technology for teaching economics will be the continuation 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.

Key words: economic education, teaching with technology, technology

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Computer technology is now ubiquitous on college campuses. 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 United States, "more than 90 percent of all public universities run some sort of wireless LAN" (Metz 2003, 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.

Have economic educators been responding to rising student expectations about using computers to learn? With little fanfare or dissention, over the past few years computer use has found its way into economics classrooms and teaching. As early as 1996, economics teachers had extensive access to computers and the Web (Sosin 1997), and a 1999–2000 survey of some department members in nearly 100 universities showed that both e-mail and the Web were used by all but a few economics instructors (Blecha 2001).1 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, for example those with investments in transparencies or lecture notes for the black or whiteboard, might view the Internet, presentation software, and perhaps even computers, as new technology. 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.

Students are increasingly ready to use computer technology 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 used the Internet. Four-fifths of the students reported that Internet use had a positive effect on their academic experience. Even more telling, the results of a Pew survey of U.S. high school students in 2002 showed 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).

Widespread use of computers to teach economics to undergraduates might be appropriate for several reasons; however, two questions are very important: first, is there evidence that using computers improves teaching on either cognitive or affective measures? Second, are the personal and professional costs to the instructor justified?

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 plagiarism and cheating issues.

**USING TECHNOLOGY IN TEACHING: VIEWPOINTS AND RESEARCH**

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 Internet use 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 toward 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 use 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. 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 toward economics.

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 had a small but statistically significant performance advantage over students in classes using little technology. They also found that some technology activities contributed to learning and others did not. The results for individual types of technology were most interesting. 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 e-mailing 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 were that experienced technology and nontechnology instructors spend about the same total amount of time preparing for classes; however, the incidence and activities that occupied their time differed. For example, the technology instructors spent more time preparing on evenings and weekends than the instructors who used less technology. They also spent more time constructing exams and less time grading them because of online Web grading.

Other recent studies include entirely online courses, with findings that 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 other comparisons of student learning. Coates and Humphreys' (2003) survey of institutions revealed that many economics departments are now offering introductory economics courses 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 to simulate lecturing. A significant negative effect measuring from three to six of 33 TUCE questions from students in the online courses compared with 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 is not 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. Another variation on using technology in ways that do not replicate chalk and talk is mastery learning, in which 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 in learning the economics material and wide latitude to customize the selection.

USING COMPUTERS AND THE INTERNET TO TEACH ECONOMICS

The familiar tools of technology—e-mail, 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 to instructors. Here are some ways to teach that were not possible a few years ago, although most of them build on tried and tested active learning approaches.

E-mail

Early technology research found that e-mail can be used to increase learning by expanding communications with students (Manning 1996). Today, e-mail is not considered innovative and is commonly used to communicate with a student or an entire class (Blecha 2001). We present an example that combines e-mail with “just-in-time teaching” (Simpkins and Maier 2004) and the “one-minute paper” (Chizmar and Ostrosky 1998).

For just-in-time e-mail, based on what happens in one class session, e-mail 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, e-mail questions can be focused on new topics for the next meeting. Although simple, just-in-time e-mail illustrates how technology can be used as more than a substitute for traditional means of communication. One of the authors, Goffe, combined the communications and convenience of just-in-time e-mail with the one-minute paper to create an active learning activity that can be used in a large or small class. The one-minute paper activity has been shown to be effective for student learning, although the effect of substituting e-mail for paper is unknown.

The basic idea of the one-minute paper is that the instructor asks the students to write a key point or question or comment about a key point for that class meeting. The steps to conduct this activity are:

1. Develop a randomized list of your students’ e-mail addresses. Select a subset of the class to e-mail; ideally, the number should be such that each student
is e-mailed a significant number of times during the semester. Randomizing a list of e-mail addresses can be done in Excel or a statistical package, although absolute randomization is not critical.

2. After class, e-mail to the selected addresses one simple question, “What was unclear to you today in class?” The Chizmar and Ostrosky (1998) 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 e-mail. However, the effect of one versus two questions and the use of e-mail on student learning is unknown.

3. The students reply to the e-mail 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, an e-mail 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 of 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, in which students are asked to visit a particular Web site and simply report back on what they find, bring current real-world information into the classroom. As opposed to imaginary widgets, as an 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 at <http://www.nmu.edu/economics/ferrarini/eis/intro.htm>. Additional links to style guides, such as the MLA style, and sites with Web page evaluation guidelines, such as that of Johns Hopkins University Library, are provided in the appendix table.

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 past 50 years. Students could be asked to prepare to answer questions on the material. What happened to the price of oil in the 1970s? What happened to the price of oil
in the late 1990s? What happened to the price of oil over the past year or so? After calling on students at random to discuss these questions, the instructor can easily 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.

Many other interesting teaching activities are described in some detail on the Web. An excellent list of technology activities for teaching economics can be accessed using the Journal of Economic Education Online Section, <http://www.indiana.edu/~econed/onlinehome.htm>.

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 Web site keys online games to teaching specific economics concepts.

Holt (2003) 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 log in 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 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. These Web-based software packages are typically purchased by the college or university and placed on servers managed by the school's Information Technology (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 Web site is created providing class lists of students and
their e-mail 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 Web site and made available to students. In some cases, copyright issues are involved, as discussed in a later section of this article. 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 e-mail 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. Via the CMS, instructors can setup quizzes and exams, enter grades, and calculate overall scores. Students appreciate the grade book feature because they can see a grade as soon as the instructor enters it, 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.

Some of the most exciting work being done for course management is the Open Knowledge Initiative from MIT that is used to create learning management systems (LMS). 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 encourage 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.

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 blog 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. 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 diversity in viewpoints 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. 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**

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 1,300 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. Another excellent source for these materials is the Online section of the Journal of Economic Education <http://www.indiana.edu/-econed/onlinehome.htm>.

**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 cannot be answered locally.

**PLAGIARISM DETECTION AND AVOIDANCE**

Some 82 percent of students admit to cheating (McCabe, Treviño, 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 producing papers for sale to students. Faculty members might choose to see what is available at such sites; one listing of them
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 to investigate unreferenced copying. However, there are many sites that Google misses, including material Google cannot index because of password protection. Some of these Web sites 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>. 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 with 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. However, 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 Web sites 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 1 percent of plagiarized papers come from one source—instead, they almost always contains 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 conforming 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.

WHAT DOES THE FUTURE HOLD FOR TEACHING TECHNOLOGY?

It seems safe to predict that technological innovations in teaching will continue at a rapid pace. Some trends are already underway. 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 office hours that are captured with an electronic whiteboard and microphone. At some institutions classes are filmed for later review (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.

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 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 of thousands can 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 in real time 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 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. New computer technology is being developed that will be more than a static presentation 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 and Wood 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. Other users of this technology include Holt (2003), whose economic experiments and simulations can also be run in class (or on the lawn) with 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 Web sites. 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.

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. The U.S. military has used such software 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: The process is characterized by a shorter attention spans, a preference for rapid information, an ability to acquire information randomly, and a love of individually controlled action. Already, Carnegie Mellon University’s Entertainment Technology Center is working on such projects for academic use. In addition, the massively multiplayer Internet games might be another step in this direction.

CONCLUDING OBSERVATIONS

During the past 10 years, teaching with computer technology, such as e-mail and the Web, has become customary throughout undergraduate economic education. This article reviews the literature on the implications for student learning, presents specific educational activities that use a number of different computer technologies, and discusses growing problems such as cyber-plagiarism, along with suggesting potential solutions. The most successful new uses of technology in the economics classroom appear to be those that encourage students’ active involvement and choice of their own learning methods and tools. The future of using technology for teaching economics will be the continuation 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 that may fundamentally affect economics instruction in the future.

NOTES

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

2. 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, Schatsky, and Sehga 2003).

3. The growth of computer use and particularly Internet use has been phenomenal over the past 20 years. By 2003, well over half of U.S. households were online, over half had Internet connections, and e-mail 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. 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), in 2003, Blackboard Inc. was the fastest-growing privately held education company in the country.


7. Dan Talley of Dakota State University and his students (all using tablet PCs) are doing much of the above in 2004.
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### APPENDIX TABLE A1. Some Educational Web Sites of Interest

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