

**Looking Beyond the Whiz-bang Technology:  
Using Mobile Learning Technology Tools to Improve Economic Instruction**

Steven C. Myers and Daniel A. Talley<sup>1</sup>

For presentation to the AEA/CAI sessions at the ASSA annual meetings, Chicago January 7, 2007

**Abstract**

This paper discusses the use of mobile computer learning technology tools for teaching economic courses and offers suggestions to improve student learning outcomes and to assist professors in becoming more efficient in their use of time. The use of computer-based teaching technologies is becoming increasingly prevalent at American universities. Two common technologies are course management systems and wireless network systems. When these are combined with the use of Tablet PCs that allow the use of digital ink-enabled software by instructors and students, new pedagogical tools become easier to use in and out of the classroom. In addition, web-based support tools have been developed to support economic instruction and innovations continue to appear. When combined, the use of computer-based teaching technologies can combine to form a dynamic teaching environment that is highly mobile, ubiquitous, and stimulating.

The purpose of this paper is to describe the mobile learning technology that harnesses the academic versatility and power of a Tablet PC to enhance student learning and engagement while increasing the efficiency of instructor's use of time. The paper discusses current software and hardware tools in general terms and follows with specific examples of how this environment can be used to augment economics instruction within and outside of the classroom. The paper discusses specific areas of instruction where the use of these technologies exhibits especially significant net benefits to student learning, with a focus in the following areas: Computer-assisted presentations, assignments and student self-evaluation; electronic evaluation of student written work; virtual office hours and distance learning. The paper also provides information on effective use by experienced instructors who have used these technologies in their own classrooms.

---

<sup>1</sup> Steven C. Myers is SoTAL Fellow and associate professor of economics at The University of Akron, Akron, Ohio, 44325-1908, [myers@uakron.edu](mailto:myers@uakron.edu)

Daniel A. Talley is associate professor of economics at Dakota State University, Madison, South Dakota, 57042, [Daniel.Talley@dsu.edu](mailto:Daniel.Talley@dsu.edu)

## Looking Beyond the Whiz-bang Technology – Mobile Learning Technologies

### I. Introduction

Computer-based learning environments are increasingly becoming commonplace at colleges and universities across the United States. Two computer-based technologies are becoming increasingly prevalent in the delivery of on-campus instruction: (1) online course management systems and specialized collaborative environments that permit electronic communication of classroom instruction materials to students, among students and between student and instructor; and (2) wireless network systems that allow faculty and students with mobile computers to communicate with their campus networks. However, recent innovations in laptop computing have led to the development of a computer that is very well designed for use in teaching: Digital pen-based mobile PCs that use digital ink enabled software. These mobile PCs are controlled with the use of a digital pen and are called Tablet PCs. The Tablet PC represents a significant step forward in mobile computing learning technology. Moreover, Internet-based support tools are being continually developed to support economic instruction. When combined these mobile computing learning tools can be combined to create a learning environment that we argue is an evolutionary leap forward technologically and promises curriculum and pedagogy changes that will increase efficiencies of educational production and enhance student learning of economics.

The purpose of this paper is to describe the use of mobile learning technology tools in general terms and how these tools can be used to augment economics instruction in the classroom. The paper discusses areas of instruction where the use of these technologies potentially exhibits significant net benefits to student learning, with a focus in the following areas: computer-assisted presentations, assignments and student self-evaluation; electronic evaluation of student written work; virtual office hours and distance learning. The paper also provides information on effective use by experienced instructors who have used these technologies in their own classrooms.

This paper is therefore organized into three parts: Section II discusses the necessary hardware and software to create a wireless teaching environment; Section III describes how these tools may be used in the traditional classroom to successfully promote learning; and Section IV describes how these tools may be used outside of the traditional classroom and indeed inside the virtual classroom to help promote student understanding of economics. Section V concludes by examining areas of future development.

The authors of this study are employed at different institutions in the Midwest. They have many years of combined experience evaluating the evolution in computer educational technology that has occurred over the past two decades. While they may be characterized as technophiles, they are both nonetheless professional economists. Therefore their primary consideration when evaluating and assessing a new computer technology is to determine whether the marginal benefits of incorporation and use in their courses outweighs the marginal cost. In particular, the associated improvement in student learning of economic content and attitude towards economics must justify the learning costs associated with the implementation of any new computer technology. The authors have not approached this area with a “kid in the candy store” perspective, merely excited by the prospect of having a new toy to introduce to our students. Rather their perspective is that of an analytical social scientist observing with interest how our subjects, our students, interact in this high technology environment with the course material, the instructor, and each other.

It is appropriate to start with a brief discussion of the author’s background and experience with these new technologies. Daniel Talley is associate professor of economics at Dakota State University where he has taught since

## Looking Beyond the Whiz-bang Technology – Mobile Learning Technologies

1996. In Fall 2003, DSU completed the integration of a trio of teaching technology initiatives which constitute a mobile computing technology environment. DSU is a Tablet PC university where all students and faculty have Tablet PCs. This has been the environment in which the principles of economics courses offered by the university have been taught since that time. These three teaching technologies are (a) the WebCT course management system, (b) a campus-wide wireless network added on top of our existing wired backbone network, and (c) the required use of a digital pen-enabled laptop computer and digital ink-enabled software (largely the Gateway M275 Tablet PC computer, the Microsoft Windows XP operating system for Tablet PCs, and Office 2003 which is digital ink-enabled and backwards-compatible). In addition, the use by this instructor since 2002 of P. Romer's Aplia course support system— a commercial, Internet-based, instructional resource site with course management features designed to enhance principles of economics courses— in this environment resulted in a fuller integration of Aplia's resources into the principles courses.

Steve Myers is SoTAL Fellow and associate professor of economics at the University of Akron. Like DSU, the University of Akron offers a total wireless networking coverage, being often cited among the top wired and unwired campuses in the nation. Laptops have been a mainstay of faculty since early laptop initiatives in the mid to late 90s and the comprehensive laptop initiatives underway since 2000. Indeed in the 2007 round of laptop offerings we hope to see a strong presence of Tablet PCs being offered if not the primary recommendation. Like DSU, UA is a WebCT school and provides many additional web based services for students and faculty alike. Since beginning in 1996, most classrooms in the university have projection and sound support and some departments such as economics have three dedicated classrooms fully wired for projection and including other support such as DVD, VHS and remote delivery of content. UA has been a pioneer in synchronous distance learning and was at one time the largest installation of the rear projection SMART boards in the nation. Some classrooms, including one in economics, have made use of SMART Symposium and SMART Synchroneyes software ([www.smarttech.com](http://www.smarttech.com)). Only among a few have the Tablet PCs been used in instruction and are being evaluated for the next faculty laptop refresh program. Students at UA do not have to purchase a laptop or Tablet unlike DSU, however, casual observation and a recent local survey show that most students do indeed purchase laptops for their use.

This paper addresses three different scenarios. It is presumed for discussion that all students may have access to some computing resource while out of class. The first and most common scenario has the instructor using the Tablet PC in a wireless network both in and out of class where the students are not required to have either a laptop or the Tablet PC in class. The second most common scenario includes students who are required to use a laptop while in-class. The third and least common, but possibly the most preferred, has each student with in-class access to a Tablet PC. The authors of this paper teach environments like scenario one and three.

It is the author's hopes that by sharing our experiences with this cutting edge technology, both positive and negative, that our colleagues in academia may benefit. As participants in the ongoing dialogue within our profession as to the benefits of integrating computer educational technology into the classroom, we hope that the following material will shed some light on the possibilities in student learning that can be achieved using this technology.

The research on the use of computer technology to improve student learning seems to be evolving toward a consensus that, with appropriate use, educational computer technology can have a significant positive effects on

## Looking Beyond the Whiz-bang Technology – Mobile Learning Technologies

student learning and attitude toward economics. The use of the Tablet PC in a wireless teaching environment to improve student learning in learning is an area in which relatively little formal evaluation has occurred until recently.<sup>2</sup>

The potential benefits of the use of computer educational technology within and outside the economics classroom is well established. See, for example, Becker and Watts (1996 and 1998), Manning (1996), Agarwal and Day (1998), Parks (1999), Simkins (1999), Becker (2000), Ball and Eckel (2004), and Sosin, et al. (2004) for excellent discussions of the potential usefulness of many aspects of computer educational technology. Becker (2003) reports “Bill Greene and I argue that we can increase the attractiveness and meaningfulness of our quantitative methods courses by getting students into computer labs for hands-on activities with data associated with the headlines students read in newspapers, hear and see on TV, or experience on the Internet.” In arguably the most comprehensive study conducted to date, Sosin, et al., report the following:

“Using institutional fixed-effects regressions, we find that technology usage, as measured by a dichotomous variable comparing classes using extensive technology to those using little technology, has a small but positive effect on student performance. More importantly, our results using separate variable for various types of technology use indicate that some uses enhance student performance and some do not. Likewise different uses have different effects for micro- and macroeconomic courses.”

However, the research regarding the impact of the use of Tablet PC technology on teaching and learning in economics is less well established. Mary Dixon (2006) has done it (see below) and many other Tablet PC evangelists are now using the Tablet PC in their classes, discussing it on online and in email communications and it is time for more assessments to begin. Boylan (2004) carefully points out the success that Bob Parks (1999) has had in using and modifying his PowerPoint delivery and how students like multimedia. What has happened since that article is that Bob is now using a Tablet PC to illustrate PowerPoint, to draw on the slides, to write equations and draw graphs and to generally transform PowerPoint from its static use to something more responsive and dynamic. Now take what Bob is doing and see what Mary Dixon is accomplishing when all the students have Tablet PCs and can draw along and receive immediate feedback. As Boylan says in referencing Kaufman and Kaufman (2002), the major impediment to learning to use graphics and reproducing the instructor’s blackboard graphics is lack of practice and understanding the concepts. There is room for the Tablet PC and collaborative software to soar here.

Most recently, in an unpublished manuscript shared with the authors, Phillip Holleran (2006) examined the impact of the use by the instructor of Tablet PC technology in two sections of introductory macroeconomics compared with a control section that did not utilize the Tablet PC technology. The study reports essentially insignificant results regarding the Tablet PC use on the impact on student performance in two sections of macroeconomics as measured by final course grade and a separate post-test of 15 multiple choice questions. Although this result is perhaps not surprising in light of other studies which have yielded similarly inconclusive results, the limited use of the Tablet PC in this study to supplement the lecture and group work suggests that there may be other more fruitful avenues by which mobile learning technology may be employed to enhance student learning. Therefore, the need for additional study to determine the conditions under which Tablet PC use in a mobile computing environment could prove most effective is suggested.

---

<sup>2</sup> Berque and Prey (2006) edit a volume of assessment research in the use of Tablet PCs being the best of papers presented at WIPTTE 2006, the Workshop on the Impact of Pen-based Technology on Education.

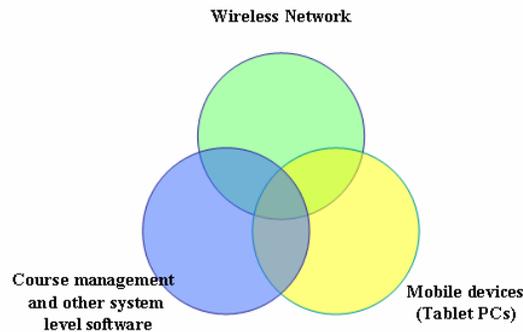
## Looking Beyond the Whiz-bang Technology – Mobile Learning Technologies

With this in mind, the goal of this paper is to suggest ways in which the mobile learning technology environment, making full use of the capabilities of wireless networking, projection, and the Tablet PC, can be leveraged to achieve efficiencies and successful student learning outcomes. We shall discuss the technologies available to establish a mobile learning environment and the various ways in which it can be used to enhance student learning both in and out of the classroom. We call for the evaluation and testing of these technology-enhanced instructional methods in future research.

### II. Basic Elements of Mobile Learning Technology Environment

The phrase “mobile learning technology environment” used herein describes the combination of three fundamental computer educational technologies: The classroom management software accessible over the campus network (e.g. WebCT, Blackboard, etc.) or a similar software designed to manage content; the use of a wireless network—a series of wireless routers and hubs that are installed in every building and campus green space so that a student in any class can access the campus network; and the use of a Tablet PC computer by instructors and/or students (see Figure 1). It is appropriate to examine each element of the mobile learning technology environment in turn.

Figure 1: Three legs of a Mobile Learning Technology Environment



#### The classroom management system

Many colleges and universities now employ the campus-wide use of a classroom management system. Both DSU and UA use the WebCT classroom management system. Classroom management systems allow instructors to make available electronic documents and resources for use by them and their students in every class they teach. These systems are typically Internet-based, allowing them to be accessed 24/7 whenever and wherever the student and instructor have Internet access.<sup>3</sup>

These systems allow the instructor to organize their course resources in a manner that is similar across courses at an institution, reducing the ‘learning curve’ for students, while providing an extensive array of features for the instructor. Instructors create a course site which they can use to provide any desired electronic classroom resources. A typical economics principles course may include: an announcements ‘home’ page; a dynamic syllabus

<sup>3</sup> This is not to say that only course managements systems provide one of the three legs of the mobile learning technology educational environment. Many faculty are using the Internet for blogs and wikis. In these sessions, Steve Greenlaw (2007) reports on using a wiki in a seminar class on globalization.

## Looking Beyond the Whiz-bang Technology – Mobile Learning Technologies

page; a grade report page, containing scores for all exams, homework assignments and course projects; the online quiz engine allowing the instructor to offer chapter or other quizzes; and pages that link to other Internet or instructor-provided resources.

The ability to link to other pages on the Internet provides access to a wide array of learning materials for the students. These basically fall into two categories, instructor-provided content and general Internet content. Instructor-provided resources could be fairly extensive, including: (a) chapter-by-chapter lecture notes page containing links to incomplete chapter lecture notes created by the instructor (in Microsoft Word or Journal format) that allow the students to fill in key concepts, definitions, diagrams, and graphs and better follow the lecture; sample midterm and final exams and answer keys, and (b) streaming video and/or audio clips containing past lectures and supplemental information.

Examples of general Internet content could include other supplemental course resources available over the Internet or commercially available course support products. A link to the textbook publisher's website where the students access publisher-provided resources is a common supplemental course resource. It is often possible to find useful student material, such as chapter practice quizzes for students and chapter PowerPoint files for instructors.

In addition there is a huge amount of economic information available via the Internet. Links could be included to take students to sites with interesting economic content, such as current Federal Funds rate data from the Minneapolis Federal Reserve website (<http://www.minneapolisfed.org/>) or the Consumer Expenditure Survey data on the Bureau of Labor Statistics website (<http://www.bls.gov/>).<sup>4</sup> Assignments making use of the most current economic data available can also be made available via the course website and the assignments may be assigned, turned in, graded by the instructor, and returned to the student completely electronically. Or the course website may provide a link to a more sophisticated Internet-based course support resource for economics principles courses, such as a link to P. Romer's Aplia product.<sup>5</sup>

### The wireless network

An important element of mobile learning is the use of a wireless network. The wireless network is not actually an independent network but typically consists of a wireless 'layer' that is integrated into the wired 'backbone' campus network. A wireless network therefore merely expands the accessibility of the campus network without adding any new capabilities beyond wireless access. The construction of a wireless network involves adding wireless access points to each building, providing coverage for all academic classroom and office spaces if not all common spaces on campus. It is important that sufficient wireless access points and underlying capacity to handle the expected

---

<sup>4</sup> An excellent online resource for instructors looking for websites with economic content is the Resources for Economists website maintained by Bill Goffe at <http://www.rfe.org>.

<sup>5</sup> Aplia is designed for use with a wide range of classes and textbooks. Aplia permits the assignment of graded homework assignments, with a matching ungraded practice assignment. Another feature is the inclusion of simple to use, well-designed online experiments that allow students to participate in simulated markets to derive the results predicted by theory through their own actions.

## Looking Beyond the Whiz-bang Technology – Mobile Learning Technologies

number of users is taken into account in the design of the wireless network.<sup>6</sup> The hardware that operates the network can often be effectively hidden, so there may be few visible clues that the wireless network is in operation.

An important element of any wireless network employed for academic use is the wireless computer projection technology. This enables an instructor to project wirelessly from her own computer. At DSU it is possible to connect wirelessly to the campus network and then run a software program, called AirProjector, allowing any instructor's computer to wireless connect to any projector configured for wireless use in any properly configured classroom. This has the advantage of 'un-tethering' the instructor from the computer station typically located at the front of the room, allowing the instructor to move about the room during the class session while remaining wirelessly connected to the projector. The AirProjector software can be installed on both faculty and student computers. This allows any mobile device to use the program if the projector is available. This also enables the faculty member to 'share' the projector with students, allowing them to project if the instructor releases the projector. Whatever is displayed on their computer screen is projected for the class to view.

At UA no wireless projectors are yet in use, however, in economics, we have experimented with SMART technologies LINQ which allows remote connection from the Tablet to the in-classroom instructor's computer which is wired to the projector.<sup>7</sup>

A wireless network also allows the instructor to take the Tablet PC between the office and the classroom. All resources are therefore available to the instructor during class. The computer can essentially be pre-configured prior to coming to any lecture by opening the programs, documents, and browser windows before class and taking the computer to class already on or in a 'hibernate' mode, saving time at the start of class.<sup>8</sup>

### The Tablet PC

The third component of the wireless teaching environment is the use of a digital pen-enabled Laptop or a Tablet PC by instructors and students. Tablet PC's come in a number of different styles. The 'slate' style tends to be smaller than a traditional laptop with less functionality—no disk or CD/DVD drives, smaller screen area, no external keyboard. A 'hybrid' style is usually a slate like Tablet PC with a detachable keyboard. The 'convertible' looks exactly like a regular laptop but the screen can swivel 180 degrees and fold down and lock so as to be operated as a flat slate-style Tablet PC where, instead of using the touchpad mouse, the pointer is controlled on screen by the stylus.

The Tablet PCs used by the authors are 'convertible' models by Gateway. The Gateway M275 is a notebook Tablet PC. It possesses the full functionality of a laptop, including the usual features such as a laptop keyboard, CD/DVD drive, and 13" diameter screen. Although larger than the typical pure-Tablet slate-style PC, it is light enough to carry while lecturing. It is controlled by using a digitizer pen or stylus that functions as a mouse by tapping on the screen. All computer functions are controlled via the stylus, with an electronic keyboard appearing as

---

<sup>6</sup> Installing the proper number of wireless access points is important for the wireless network to function properly. If too many users are trying to make serious use the same access point, delays in data transmission could occur with corresponding detrimental effects on student engagement and learning. Some collaborative tools such as Classroom Presenter below and wireless projection do put pressure on the network.

<sup>7</sup> LINQ requires use of either a SMART Board or SMART Symposium. ([www.smarttech.com](http://www.smarttech.com))

<sup>8</sup> Through use of virtual private networking (VPN) and wired and wireless access to the Internet at home, the classroom and office get easily extended in their entirety to the home.

## Looking Beyond the Whiz-bang Technology – Mobile Learning Technologies

necessary. Advances in handwriting-to-text and voice recognition software have enabled composition of documents using a stylus or the built-in microphone. The screen is tapped to left-click and a button on the stylus can be depressed to tap a right-click. Alternatively, holding the stylus on the screen motionless for a couple of seconds also completes a right click. The other Tablet used is the Gateway M280E which is similar to the M275, but offers a different digitizer pen, has a larger wide 14" screen, and extended battery with the resultant increased weight. Both models have already been superseded by the M285E which became available in 2006 (see [www.gateway.com](http://www.gateway.com)).

### Tablet PC software

Every tablet on the market uses Microsoft's Windows XP Tablet PC Edition, which permits the use of digital ink-enabled software. Office 2003 is an example of digital-ink enabled software allowing digital inking to be used throughout the suite including Word, Excel, Outlook and PowerPoint. For example, in Microsoft Word there are three toolbars that are available to allow the digital ink user to include digital ink functions to their compositions.<sup>9</sup> The stylus can be used to write in digital ink in the Word document. These digital ink annotations become a part of the document when saved and are backwards compatible, which means they can be viewed on older, non-tablet versions of Word, (although the viewer could not write).

It should be noted that the digital ink support in Word is pretty solid. The three toolbars provide a wealth of digital ink functions, including writing, highlighting, and a full palette of colors and pen widths. This is in fact one authors preferred program for student note-taking. In his classes, the students take digital ink notes on Word format lecture notes provided by the instructor that are incomplete, requiring them to add definitions, equations, graphs, and highlights to complete them. In contrast, some commonly used software packages do not provide support for digital ink that is as functional or easy to use. Two such programs for which digital ink is available but limited would include Microsoft's Internet Explorer and Adobe Acrobat.

Two other Microsoft software programs designed to take fuller advantage of the digital ink feature are Microsoft Journal and OneNote. Journal is a note-taking program that can capture handwritten notes and drawings, convert handwritten notes to text, import graphics files, and distribute between instructor and students. Non-Tablet PC users can view these files using a free Journal Reader viewer, that is installed by default on Microsoft Windows 98 or later according to Microsoft.

One of the most useful features of Journal is that you can print from any application (e.g. Word, Excel, Adobe Acrobat, Internet Explorer, your favorite statistical program) into Journal format. This allows you to create a copy of almost anything that is viewable in electronic format that you can then annotate using digital ink. This is especially important for those programs and files that are not yet digital ink-enabled, as it provides a quick-and-easy method for converting them into an ink-able format.

Microsoft OneNote is a more fully featured note-taking software package. In addition to taking full advantage of the digital ink capabilities of the Tablet PC, it allows you to import a wide range of files, including video and audio files, and URL links directly into the OneNote note document. It also has more advanced organizing features, allowing students and instructors to keep the equivalent of an electronic binder of related information, for

---

<sup>9</sup> The three toolbars are "Ink Annotations", "Ink Comments", and "Ink Drawing and Writing" in Word 2003.

## Looking Beyond the Whiz-bang Technology – Mobile Learning Technologies

example the notes for all of your classes, in one file. This program has the advantage of greater integration of related electronic files of disparate type. This could be useful for a student to put together a portfolio of work from one or more courses.

### Handwriting-to-Text and speech recognition

Two other additional features of the Tablet PC are also worth special mention. There is a handwriting-to-text conversion which is very impressive. Even with handwriting that is difficult to read, the character recognition program has what appears to be approximately 85- 90% accuracy. With extensive use, it is said that accuracy can improve to 95%, or even better with commonly used words, letters and characters. In a classroom setting, this is especially useful. By use of the Tablet PC input panel, you can point to a virtual keyboard or handwrite items that are instantly converted to typed text, with full reviewing and editing capability before inserting into the document. Terms, definitions, and descriptions that used to be handwritten during lecture can now appear as typed text ‘on the fly’ during lecture. As part of the free Microsoft Education Pack discussed below the same can be done for handwritten equations that are converted to typeset quality.<sup>10</sup>

The tablet also has a speech recognition ability that is most impressive. The speech recognition can be trained to recognize your particular dialect and pronunciation, thereby making it eventually highly accurate. Although not practical for classroom use due to the need for a relatively quiet environment, it is well suited for use in an office or home office setting. Use with a headset with an attached microphone is recommended. Both the handwriting-to-text and speech recognition controls are accessible from the Tablet PC input panel, that can be set to pop up with a wave of the pen, literally—it appears when the stylus is rapidly moved back-and-forth near, but not touching, the screen.

### Evolution

The wireless classroom environment of today is a far cry from the early days of computing which had both faculty and students walking across campus to visit the building housing the mainframe and its terminals. Computing resources and the students were as far apart as possible. As computer labs began to appear across campus, students could now have a place to work on projects outside of class. As the dumb terminals slowly became replaced with personal computers, more students could benefit from the new word processing programs. Nevertheless, these were public computers and not personal computers. The student still had to go to a specific location to work. As we jump ahead to a wireless campus with student-owned laptops and Tablet PCs, mobility and portability allows the student the freedom to work anywhere-any time. In schools where laptop use is not required, student use of laptops in the classroom is minimal. There are two reasons for this. First, taking notes on a keyboard in most classes is not sufficient and a paper notebook is required for those notes unable to be typed and to manage the paper handouts in class. The second reason is the form factor of a laptop is not only limiting but socially obtrusive. The Tablet PC represents an

---

<sup>10</sup> Microsoft Equation writer is part of the Microsoft Educational Pack free for download from <http://www.microsoft.com/windowsxp/tabletpe/>.

## Looking Beyond the Whiz-bang Technology – Mobile Learning Technologies

evolutionary jump. It replaces the paper notebook, allows inclusion of digital handouts, and allows for a natural writing style while taking notes.

The inherent flexibility of use is part of the design philosophy of the Tablet PC. Not restricted to keyboard and mouse, one may write in digital ink or compose by voice instead of typing. For example, much of this paper was dictated using the Tablet PC's speech recognition tool. We assert that the Tablet PC represents a new evolution in the 'personal' computer. One of its strengths is that it is a technology that allows students and instructors to have greater flexibility in the way material is presented and evaluated. By allowing access to a wide range of written, audio, and visual information, the instructor can integrate classroom pedagogy well beyond the 'chalk and talk' that is still prevalent in economic instruction today. When combined with active learning and collaborative curriculum the Tablet PC truly represents an unparalleled opportunity for growth in student learning.

### **How should this new phenomenon be evaluated and assessed?<sup>11</sup>**

For both the faculty member and the student the Tablet PC represents a true ubiquitous communication device which in a wireless environment supported by appropriate software offers a 24/7 mobile learning environment. How might we assess and evaluate the impact of Tablet PCs on the higher educational delivery system? The Tablet PC should be used any time the marginal benefits of its use exceeds the marginal cost. This might represent the marginal benefits and marginal cost over the alternative of a non-computing environment or the margin over the heavily computerized environment already using laptops for every student.

Twining (2002) suggests three different possible levels of the impact of a Tablet using the Computer Practice Framework for assessment. At the first level, the Tablet PC may support greater efficiency, but not actually change the curriculum. Second, using Tablet PCs may change the curriculum and invigorate the teaching and learning process, but this might have been achieved without Tablet PCs. Third, at the highest level, the curriculum is changed and the impact could not have been achieved without the Tablet PC. These represent three levels of evaluation and assessment of the technology.

Alverado (2004) summarizes the "Tablet PC and Computing Curriculum workshop" sponsored by Microsoft research in August of 2004.<sup>12</sup> Thirty-two computer science faculty members were brought to the University of Washington to discuss how the Tablet PC might dramatically alter the educational process. While the white paper was geared towards the computing curriculum we might read it with regard to the economics curriculum as well. They suggest that when integrating Tablet PC use, faculty must rethink what we teach students and how we enable students to learn. Some of the questions addressed (and reworded slightly for our purposes) include:

---

<sup>11</sup> We recognize that distinction between evaluation and assessment but will blur the lines often in this paper. Evaluations are understood to discover whether or not the inclusion of the Tablet PC makes sense on the basis of whether using the tablet is more favorable than an alternative. Assessment on the other hand requires study into whether or not student learning or other objectives have increased over a rigid baseline. Thus, it is possible to have a very favorable evaluation while lacking evidence of a positive assessment.

<sup>12</sup> This, in 2004, seems to be the first meeting of faculty with Microsoft Research specifically on the Tablet PC, a second was Anderson and Prey (2005), and in the third year the Workshop on the Impact of Pen-based Technology on Education (WIPTE) was sponsored by MS Research and held at Purdue, Berque (2006). The next WIPTE is June 11-12, 2007 and as of this presentation the call for papers is currently active. (see <http://www.itap.purdue.edu/tlt/conference/wipte/>).

## Looking Beyond the Whiz-bang Technology – Mobile Learning Technologies

- “What are the ultimate outcomes for (economic) education?”
- How does the Tablet PC change the interaction between teacher and student and how will this impact classroom pedagogy?
- How does this new type of interaction affect course content and the (economic) curriculum?
- Are these new pedagogies and strategies applicable to other disciplines?
- What are the differences between classes in which only the teacher uses a Tablet PC and classes in which all the students also use one? (And)
- Are there replicable strategies, tools, and techniques that can scale across large numbers of teachers and students?”<sup>13</sup>

These questions are also part of the assessment that the economics profession will have to answer.

The Alverado paper discusses the value of digital ink communications and mobility in higher education while pointing out the necessity of having certain enabling technology and specialized software. Chief among these is the need for wireless networking. Their vision included nothing less than transforming higher education by helping to create and exploit this new learning environment. This results in a new range of communication modalities both in and outside the classroom. It embraces everything from “chalk and talk” lectures, to web-enhanced classes, to distance learning classes and indeed to a total immersion of anywhere/anytime learning. Textbooks and references can be completely online or downloaded to the tablet. These e-books can be annotated and searched and used in a way not previously and conveniently available to students or faculty. As software frees us from the LAN and opens up the WAN, anywhere/anytime learning can be both asynchronous and synchronous.<sup>14</sup> With new Tablet PC software and collaboration tools a new environment for learning is beginning and evolving. The wireless learning environment will make virtual office hours as normal as real office hours. Companies like Aplia and major publishers in economics will discover the value of enhancing their software with digital ink support and the drawing and manipulation of equations and graphs will be done by pen stylus and not by mouse. This more natural form factor will lead to a true (r)evolution in higher education.

With declining University budgets, more competition among instructional units, and great numbers of students, the lecture methodology remains. Evaluating how technology can enhance student learning and add efficiencies will be of paramount importance to our profession. Modifying chalk and talk, eliminating it where possible, and enhancing collaboration and active learning of students is well accepted among economic educators. We believe the Tablet PC and related mobile learning technologies will foster large changes in how we educate our students and how we do our job.

How can we progress in some cases from no technology in the classroom to the kind of wireless learning environment that we posit here? Carryer (2006) has shown students have a marked preference for the use of the

---

<sup>13</sup> Alverado (2004) pp. 1-2.

<sup>14</sup> Extending the classroom to the WAN requires the use of virtual private networking (VPN) to stay immersed when out of range of the physical campus. LAN refers to a local area network (think computer lab) and the WAN refers to the wide area network (think campus). The ability to VPN makes the campus extend to the student and not the other way around.

## Looking Beyond the Whiz-bang Technology – Mobile Learning Technologies

Tablet PC as an alternative to transparencies and an overhead projector not only for form, but also because the lectures can be recorded and stored for student use. This represents the faculty member who uses the Tablet PC to change static presentation methodology to dynamic. Martha Olney of UC Berkley, uses her Tablet PC to mark up and bring alive PowerPoint slides.<sup>15</sup> She had previously used transparencies and had to switch equipment to show maps or photos, or use bad photocopies of photos on transparencies. By using the Tablet PC to replace all of that, she used PowerPoint. With the tablet she was able to annotate tables and graphs as she normally would have done with transparencies. She could then create pdf files of the PowerPoints in advance and post them on the course website.

Scharff (2006) shows how the Tablet PC can be used to enhance group work in a learning community of students where the professor has a tablet and each group of students share a tablet. This is important since at many schools funds will be limited and enough tablets cannot be purchased for every student. Students in learning communities and collaborate groups will share a tablet in-class and may be able to borrow the tablet during off class hours. In this way schools have an opportunity to prove for themselves the value of collaborative and active learning strategies using both professor and student-owned Tablet PCs.

If a school is already a laptop school, that is, the school where every student is required to have and bring a laptop to class, the transition to tablets may be easier. Rose-Hulman University had required student laptops for ten years before Hubbard (2006) introduced a small number of Tablet PCs into his calculus class. He shows that the Tablet PC contributed positively to student learning in calculus. While students had been long required to use and bring their laptops, the increase in student learning can not be from the use of the laptop portion of the Tablet PC and must be from the special features that the Tablet PC brings, notably the better form factor and the use of digital ink. In economics, it is not so difficult to imagine that teaching with laptops in the classroom would be especially difficult. Our use of diagrams, graphics, equations, and more emphasize the use of the pen. Digital ink shows advantages over the pen and paper and the use of Tablet PCs in economic instruction seems natural. The value of an active learning collaborative and wireless computing environment will begin to show its worth.

Thede (2006) shows that using specialized presentation software with the Tablet PC increases class participation. Similar to the clicker technology that has the ability to record student attendance and make active participants of the students, specialized presentation software that broadcasts the professor's notes and comments to every student tablet in the classroom may have the same effect. When students can complete assignments, exercises, polls and more during class and have those answers immediately available to the professor, both student engagement and time on task is enhanced. Every student becomes an active participant whose quality of participation may be judged at any moment, giving the professor the signal to slow down or speed up the delivery as the student' seem to know that material or not.

One such presentations system was developed by Richard Anderson (2006). He developed a Tablet PC based system called Classroom Presenter. Faculty and each student have a Tablet PC and the class notes, whether created

---

<sup>15</sup> Some discussion of this is in Myers (2004b) and Myers(2004a). In Myers (2004a) there are six uses of technology posited to enhance student learning in economics. They are Electronic Grading, Interactive Presentations, Minute Paper and Muddy Point classroom assessment techniques, Testing for Mastery Learning, Electronic Portfolios, and Active Engagement Exercises. Much of this paper draws on the ideas set forth therein. (Conversation with Martha Olney on tch-econ, December 2006 during a discussion of the use of Tablet PCs in the classroom.)

## Looking Beyond the Whiz-bang Technology – Mobile Learning Technologies

ahead of time or during the lecture or both, are automatically broadcasted to each student. Each student at his own tablet can annotate the slides as they are shown. Students do not have to worry about copying everything down because what the professor broadcasts automatically appears on each student's Tablet PC. The faculty member can ask students to write an answer to a question and their responses will be wirelessly sent back.<sup>16</sup>

Mary Dixon (2006) uses a product called DyKnow Vision which has even more features than Classroom Presenter.<sup>17</sup> She and her colleagues translate the “chalk and talk” lecture into a dynamic and interactive instruction method they call “animate and collaborate.” DyKnow Vision enhances student-teacher interaction through “collaborative note taking, student response tools, content replay, and anywhere, anytime access. Teachers can use DyKnow Vision to instantly transmit content to student screens for annotation. (<http://dyknow.com/products/vision> cited January 2, 2006)” We take the liberty of quoting extensively from their paper to illustrate how the wireless Tablet PC transforms the learning environment.

“(I)n the process of redesigning courses to take advantage of DyKnow Vision and pen-based computing we have: (1) converted static graphs from the textbook into a dynamic series of sequential components so that students can see the process of creating graphs, and the factors that determine the shape and position of the curves. (2) Added in-class worksheets and group activities that link course concepts to resources on the web. (3) Created opportunities for students to share their notes, graphs, and worksheets with each other during class by making them part of the electronic class record. (4) Integrated exercises that use real-time business climate and company information when applying decision-making models. (5) Increased use of spreadsheet, statistical, and presentation software during class, by individuals or groups of students. (6) Used pen-based features to annotate prepared lectures or student presentations made during class. Dixon (2006)”

Mary Dixon and her colleagues have applied this technique to a variety of classes, including some of the most quantitatively-demanding classes. Indeed, it is in the quantitatively-demanding disciplines such as STEM and economics that the tablet is most valuable in higher education.<sup>18</sup>

### III. Teaching in the Wireless Classroom

The wireless technology environment offers several instructional advantages to the economics instructor. By making use of state of the art computer technology, the wireless Tablet PC classroom can improve the efficiency of routine pedagogical techniques and affords the instructor the opportunity to integrate additional pedagogical activities into the classroom.

---

<sup>16</sup> This product is free for download from <http://www.cs.washington.edu/education/dl/presenter/>.

<sup>17</sup> DyKnow vision is originally authored by Dave Burque at Depauw and may be purchased from <http://dyknow.com/>.

<sup>18</sup> STEM represents science, technology, engineering and mathematics and is a typical representation of the quantitatively-demanding disciplines. To this list we certainly add economics.

## Looking Beyond the Whiz-bang Technology – Mobile Learning Technologies

### Wireless projection

One area in which the wireless technology environment offers an advantage to the instructor is in the presentation of information. As already noted, the wireless classroom allows the instructor to wirelessly connect to a projector. This enables the instructor to become a much more dynamic presenter of information, allowing the instructor to circulate around the room to answer questions and address issues, especially when students in large sections are working in small groups. The AirProjector software also allows students to take control of the projector from their laptop, allowing them to show the entire class what is on the screen of their own computer. This leads to more efficient student presentations, either individual or groups, as students can quickly and efficiently take control of the projector from each other. The instructor can override control at any time.<sup>19</sup>

### Wireless Internet access

A related area of presentation concerns the resources that the instructor is able to present from the Tablet PC. In particular, full access to the Internet is enabled by the use of the Tablet PC. As mentioned above, by finding a website, printing the contents to Windows Journal, and using a wireless display, any Internet site becomes a forum for discussion and written comment, which can be saved and disseminated after the presentation is complete via the course management software system. Therefore, current events become very easy to integrate into a lecture, even on the fly. The combination of wireless Internet access, digital ink, and the course management system are a powerful combination for including timely references into a discussion.

### Online quizzing

Another area where the wireless classroom offers a high technology approach to an existing pedagogical technique is in the use of online quizzing. Most course management systems have well developed online testing systems. The online quiz engine in WebCT, for example, is quite robust, allowing the instructor to load many electronic test banks from textbook publishers and elsewhere to instantly create an extensive database of questions from which to create tests. In addition, the editing capabilities in WebCT permit the instructor to modify all aspects of a question or to draft their own in a variety of formats, including multiple choice, true/false (binary multiple choice), short answer, and essay questions.<sup>20</sup>

Online quiz engines can serve a variety of pedagogical purposes. They can be used at the beginning of the semester to deliver survey questions or test for learning style preferences (<http://vark-learn.com>). For example, a survey that asks questions about students' math and economics background as well as some general interest questions on current economic issues serves as a good introduction to 'get the ball rolling' in a principles course. The online

---

<sup>19</sup> An alternative to projection is the use of presentation tools like Classroom Presenter or DyKnow Vision which allows broadcast to each student's Tablet PC.

<sup>20</sup> A classroom response system (CRS) is also known as a student response system (SRS) or classroom performance system (CPS) depending on the vendor. With this system, wireless clickers are provided to the students giving the instructor quizzing and collaboration functionality. For a discussion and assessment of clickers, see Renna and Ghosh (2005). These results are tallied and displayed immediately. Software packages Classroom Presenter and DyKnow Vision offer quizzing and polling features.

## Looking Beyond the Whiz-bang Technology – Mobile Learning Technologies

quiz engine can also be used to deliver chapter ‘reading quizzes’, either before or after the chapters are discussed in class. This provides the instructor with some formative assessment regarding students understanding of the chapters.

This use of online quizzes has proven quite successful in one author’s classes. In addition to providing the instructor with an idea of the relative difficulty of a chapter and the specific concepts within for a given section of a principles course, this also provides the students with an understanding of the types of questions they may face on an exam. Indeed, often exams will include one or more of the more challenging questions from the chapter reading quizzes to provide an incentive for the students to understand the questions they missed. In addition, it provides a different type of participation credit than simple attendance.

Of course, the online quiz engine can also be used to provide ‘pop quizzes’ since the instructor has the ability to manually release a quiz to the students just prior to the start of class. And conceivably, a quiz with a sufficiently long time limit could be used to pose questions throughout a class period to motivate discussion, although this would probably be more efficiently accomplished via the use of a classroom response system (CRS) that allows immediate display of the results.

In addition, use of an online quiz engine to compose a ‘one minute paper’ at the end of each class period. Chizmar and Ostrosky (1998) describe their use of the ‘One Minute Paper’ formative assessment technique. After every class, students are asked to discuss the main point of the day’s lecture, briefly summarizing the ideas they understood well and they are also asked to identify an idea that was confusing or that they would like further information about, the ‘muddiest point’. By quickly scanning the ‘one minute papers’ that result, the instructor can follow up in the following period to clarify common questions or concerns from the students. The students receive immediate feedback and also visibly see the instructor adapting the day’s lecture to address the pedagogical needs of the class.<sup>21</sup>

In the mobile learning classroom, this can easily be set up in the online quiz engine as a two question quiz that the instructor can either preset to become available in the last five minutes of class or that the instructor can enable manually at the end of class. It would consist of two short answer or essay format questions: “What were the key points of today’s lecture?” and “What point or topic was most unclear in today’s lecture?” The students can quickly answer and the instructor can view the results immediately after class. This can even be set up for anonymous response from the students, although this would of course preclude the assignment of participation credit for this activity.

### Online experiments and simulations

There are several uses of mobile learning technology tools that move beyond replicating the experience of the traditional lecture and introduce new pedagogical elements into the classroom. One of the most interesting approaches has been the expanded use of economic experiments, simulations, and games to help students experience the results predicted by economic theories and abstract models. The use of PC- or Internet-based simulations is of course not unique to the mobile learning classroom. As noted above, personal computer labs have existed on campuses for

---

<sup>21</sup> This formative assessment technique, and many others, is described in Classroom Assessment Techniques by Thomas Angelo and Patricia Cross (1993).

## Looking Beyond the Whiz-bang Technology – Mobile Learning Technologies

decades. However, the mobile learning classroom is ideally suited to the employment of online simulations and experiments in pedagogical setting. At a higher level of technology integration where every student has their own wireless computer, the need to leave the classroom and reserve a computer lab is in fact completely eliminated.

Much has been written about the effectiveness of active learning techniques in promoting learning. In economics in particular, it has been well established that experiments can be effectively employed in many different classes at all levels of the economics curriculum. Ball and Eckel (2004) convincingly argue that the Internet can be used effectively to facilitate active learning through the use of economic experiments that are simulations of markets and other economic environments. They provide an excellent summary of three sources of Internet-based classroom economic experiments: Paul Romer's commercial Aplia system, Veconlab designed by Charlie Holt, and a digital library under development by the University of Arizona called EconPort.<sup>22</sup> These systems are designed for both in-class and outside-of-class usage.

Aplia distinguishes itself from the others for its ease of use. Aplia experiments are designed for synchronous usage, so that the students are playing with/against each other at the same time. But they do not actually have to be in the same room (or even the same country)—the Internet allows them to log in from different locations and a chat function allows the instructor and students to send messages to everyone. Aplia's experiments are very well designed to maximize ease of use by instructors, which is especially helpful for those without an extensive background in experimental economics. Although the number of variations of each experiment is relatively restricted by design, the outcomes of Aplia experiments almost always support the predicted results from theory. The Aplia experiments are well suited for use in economic principles courses.

Aplia also receives mention in two other studies of teaching technology, Porter, et al. (2004) and Boylan (2004). Porter et al. include Aplia in their excellent summary of useful online resources for economists. Boylan also highlights Aplia's success in overcoming the significant challenges of distribution and acceptance by gaining significant adoption in a relatively brief time period. The Aplia website claims 90,000 students at more than 290 institutions have used their materials (Boylan, pg. 419).<sup>23</sup>

In contrast, Veconlab offers more flexibility in the range and variation of the parameters that the instructor can set and more choices of experimental software, but does not incorporate focused problem sets or Aplia's course management system features. It is clearly intended for use by instructors with some expertise in designing and running classroom experiments and a number of experiments are available for both micro- and macroeconomics courses at all levels, principles and beyond.

These Internet-based experiment packages are extremely well suited to the wireless technology environment. They are designed for use with very large classes. They are extremely efficient so as not to overwhelm the wireless (or campus) network even with a large number of student players. The wireless environment allows the instructor to circulate among the students while retaining control of the simulation from her Tablet PC.

---

<sup>22</sup> Descriptions of Aplia, Veconlab, and EconPort are provided in some detail in Ball and Eckel (2004).

<sup>23</sup> It is not mentioned if this refers specifically to the experiments. Aplia sells the experiments separately or bundled with its other course management services. We are aware that some instructors do not necessarily make full use of all of Aplia's functionality even when those functions are available to both instructor and students.

## Looking Beyond the Whiz-bang Technology – Mobile Learning Technologies

Bell and Eckel also discuss a wireless system developed at Virginia Tech called the Wireless Interactive Teaching System (WITS) which likely has additional features, but it would seem that the benefits would apply to any wireless network would suffice. Ball and Eckel (2004) argue that the benefits to the students of “real-time, in-class, shared experience” (pg. 473) is important to the overall success of this pedagogical technique, enough so to warrant the adoption of the wireless methodology for large classes. Their empirical analysis of a comparison between a control group and an experiment group using the wireless in-class teaching system gave students “a stronger understanding of the core principles of economics and a greater ability to apply their understanding to new situations.” (pg. 477).

### Multimedia and the Tablet PC

An exciting new area in which the wireless technology environment is naturally adapted is the use of multimedia materials, accessible by disk or over the Internet. The ability to play Internet-based streaming video is again not unique to the Tablet PC. However, it is worth noting that the efficiency of today’s popular video streaming software, Windows MediaPlayer and Real Network’s RealPlayer, has progressed to the point that most videos will now play seamlessly over a wireless network, with the exception of the most congested times. This offers the instructor the opportunity to include not just media clips from news sources, but also lengthier, higher resolution video as well.

For example, the Commanding Heights series produced by PBS is a popular educational resource (<http://www.pbs.org/wgbh/commandingheights/>). PBL has created a publicly accessible website that supports the entire six-hour television program on globalization, world trade, and economic development. The Commanding Heights miniseries examines many different economic ideas and concepts, conceptually divided into the free market view, represented by Hayek, and the active government intervention view, represented by Keynes. The complete television program is available over the Internet along with support resources and additional references.

These videos could be integrated into a classroom discussion of international trade in a Principles of Macroeconomics course, perhaps after introducing the major schools of thought or during the development of the international trade component of aggregate demand. Utilizing the Tablet PC, it would be possible to wirelessly access the Internet to access the reference material and to gather data on current and past information on GDP, employment and unemployment, inflation and of course imports and exports to aid the discussion of the relationships between these economic variables.

In a more innovative approach, G. Dirk Mateer working with Thomson-Southwestern publishers has developed an Internet site called “Economics in the Movies” to allow instructors to easily pull movie clips from the site directly into the classroom. Creating clips from movies across several decades that showcase common basic economic concepts (and with permission from the copyright holders), he has created student assignments and instructor resources that allow the instructor to play the clips for the benefit of students discussion. He argues that the students are better able to recall and understand economic concepts once they are exposed to the audio and visual cues found in the video clips.

## Looking Beyond the Whiz-bang Technology – Mobile Learning Technologies

The use of visual imagery provides students with diverse learning styles an opportunity to be introduced to economic concepts in new ways. The ability of students to see movie clips from the instructor's computer in class and then access the clips at any time from their Tablet PCs over a wireless network represents the frontier of the transmission of large volumes of a/v information via the Internet. This enables the instructor to provide cinematic experiences that vividly illustrate the concepts and theories under examination in the classroom.

The Tablet PC, like most notebook computers, is equipped with a DVD player (with CD/Rom player and burner). This allows the instructor to bring in multimedia from a wide range of sources or, if the Internet is not performing up to expectations, to serve as a backup multimedia system without any additional equipment.

The mobile learning classroom therefore allows the instructor to introduce new pedagogical dimensions into the classroom and augment the efficiency with which practices that are known to be effective can be implemented. Clearly, the question that needs to be addressed is which of these uses of the mobile learning classroom are most effective in improving student learning. However, the potential clearly exists for significant improvements in student engagement and understanding.

### IV. Mobile Learning Technology Tools for Outside of the Classroom

The use of wireless networks also has the potential to expand interaction between students and between the students and the instructor. In the section that follows, the author's discuss some ways in which the communication facilitated by the use of the Tablet PC in a wireless environment.

#### Electronic grading<sup>24</sup>

Electronic grading is a combination of four steps: (1) student submission, (2) professor receipt, (3) mark up, and (3) return all in a digital medium. The first step is students' submission of exercise homework or other task. If already typed into Microsoft word digital submission is simple by e-mail or saving the digital material to a designated server. On the other hand, if the assignment is handwritten, or includes hand drawn items such as graphs and equations, then the need to digitize is the first order. With a scanning device attached to a student's computer, the assignment can be digitized and forwarded to professor. This creates a high burden on and an extra piece of hardware for every student.

There are at least three ways in which handwritten student assignments can be digitized more cheaply and efficiently. The first makes use of a fax gateway such as offered by services like Efax ([www.eFax.com](http://www.eFax.com)). The student, using any fax machine, dials a designated number given by the professor and the digitized version of the student work is sent to the professor's e-mail. A second, more robust and scalable method uses a digital sender—which may be a dedicated modern or part of a copy machine. The student submits their work to the office, and at a certain time, all students' submissions are run by a student assistant through the modem/copier. This process digitizes and sends the entire set of assignments to the professor's e-mail or designated server. A third way has the student use a Tablet PC directly to complete the assignment using the digital ink features of the tablet. When finished, the student saves the document and sends the assignment to the professor by the use of e-mail or saving to a dedicated server.

---

<sup>24</sup> Much of this discussion is elsewhere in Myers (2004a) and Myers (2005).

## Looking Beyond the Whiz-bang Technology – Mobile Learning Technologies

The next step is the professor's receipt of the assignments and if necessary their transformation into a file format most suitable for markup using the digital ink features of the Tablet PC. One of the authors makes use of a standard copier for students' submission which forwards the digital content as one or more Adobe Acrobat pdf-type files which are sent directly by attachment to his e-mail. The step of receiving consists of opening the pdf files and then saving them in a preferred format. Although Adobe Acrobat may be used to mark up files through the use of a digital pen feature embedded in the Acrobat software, this is inferior to the markup capability of Microsoft Journal. The markup tools in Microsoft Journal are excellent. Each student's assignment is marked up and the markings saved with the Microsoft Journal file. It is possible to mark up the students' assignments in other programs, for example, Microsoft Word has extensive inking and commenting features that can be used.

It's important point out the need for organization. Electronic grading will result in the same number of student submissions as the non-electronic form. But unlike the non-electronic form, each of these papers needs to be properly labeled, filed and sent back to the student once grading is complete. For this reason it is important to develop a systematic and orderly directory structure and naming conventions. For example, one author has one directory for items to be graded and another directory for items after they have been marked. In each case the file name has been preselected and the student's unique University e-mail ID prefixed or appended to the preselected name. To continue the example and to be more specific, Computer Homework Three submitted by a student with an e-mail ID of MW12 might be saved as MW12\_CHW3\_E100\_Spring2007.doc if it is a Microsoft Word file. Students are required to use a naming convention when submitting digital content. When receiving bulk submissions, it is up to the professor to name and save the individual files.

Once the file for a student is marked, it can be returned immediately to that student by e-mail or deposited on an appropriate server that the student can access. Printing each marked document, regardless of its format, to convert the document into an Adobe Acrobat pdf file guarantees its readability, portability and, if selected, its security. A good feature of Acrobat Professional is the ability to set security so the document may not be changed, printed, or even viewed without a password – whatever the instructor wants.

Using the Tablet PC as a repository of all students' submissions means that the carrying of large stacks of papers from classroom to office, to home, and back to classroom is totally unnecessary. Each professor-owner of a Tablet PC has stored on their hard drive a complete record of all students' submissions. Because of the form factor of the Tablet PC, grading takes place as naturally as with pen on paper. It is much easier to sit in one's easy chair writing on a screen than to be tethered to a desk for all work.

### Document imaging formats

Throughout this paper, references are made to Adobe Acrobat Professional and the resultant pdf files that have become a computing standard format for document portability. Mark-up tools in Adobe Acrobat Professional exist and are crude when compared to Microsoft Journal, lacking both options and flexibility. An alternative to the pdf format is given by the Microsoft Office Image Writer which produces files with the extension MDI (Microsoft Document Image format) and offers nearly the full mark-up capabilities of Microsoft Journal. For purpose of storage, markup and portability, professors simply select the appropriate printer. For example, assume that you have a student

## Looking Beyond the Whiz-bang Technology – Mobile Learning Technologies

submission containing the results from a statistical program. To prepare to grade, one only needs to choose to print those results using Adobe Acrobat, Microsoft Office Image Writer, Microsoft Journal or any other program where digital ink tools exist.

### Other Communications outside the classroom

In addition to electronic grading, other communication between student and instructor may take place because of the digital ink capabilities of the Tablet PC. For those who use Microsoft Outlook as their e-mail will discover that they can reply to e-mail messages using only the pen. This is especially useful if you need to return a supply and demand graph as part of the reply. If you do not use Outlook for e-mail communication, you can prepare your answer in Microsoft Journal or Microsoft Word using digital ink and return the document to the student by use of the “File/Send To” command. It is recommended that any file saved and returned to a student bear the course number and the student’s unique ID tag and be saved in a directory dedicated to that particular class.

Another useful communication with students is through the use of “virtual office hours.” This means that students visit online rather than attend formal office hours in your physical office. This can be done by a number of free communication programs such as Microsoft Office Communicator or MSN Communicator where inking is allowed. A program such as Macromedia Breeze (now called Acrobat Connect) allows the faculty member to enter an online environment which includes web cam, microphone, chat room, discussion board and white board. Students enter the virtual office by clicking on a posted URL or they can be invited by e-mail. Indeed, when a student walks in to a faculty member’s physical office their question most often will result in the professor drawing one or more graphs or writing one or more sets of equations. It is just what we do. The Tablet PC allows these graphs and equations to be drawn and sent not merely in e-mail but in a real time collaborative environment.

For those questions that require much discussion or explanation, the Tablet PC offers the speech recognition support necessary to convert speech into typed text. Within programs such as Word and Outlook, the speech conversion process may increase the professor’s efficiency. All that is needed is a good microphone. With that microphone, however, comes the opportunity to use the tablet to engage in what is known as podcasting, allowing the faculty member to record answers, explanations or small lectures and then either post the recording for general consumption or send it to one or more students.<sup>25</sup>

With these tools we have discussed and a few more faculty member can begin create frequently asked questions file by saving the digital responses and posting in an orderly fashion either for the professors own reference are for benefit of students directly.

### Other Software Enhancements

Microsoft Education Pack is an essential to any Tablet PC used in an academic setting. There are five free programs ready for download that will help your experience. There is a game, a program to make flash cards, and a lite version of GoBinder by Agilix. Go Binder is a one stop organizer, calendar, phone book, schedule, and notes

---

<sup>25</sup> A simple discussion and tutorial on how to do a podcast is at <http://learnecon.blogspot.com/2005/11/teaching-and-learning-economics-with.html>.

## Looking Beyond the Whiz-bang Technology – Mobile Learning Technologies

space organized by class. The program includes a printer driver so that anything that can be printed can be sent to GoBinder just by ‘printing’ to GoBinder. Another indispensable program is “Send to MS Office One Note” which is a printer driver that allows anything that can be printed to be sent to your One Note. For economists, what could be greater than an equation writer? This program works like the input panel, you handwrite an equation and it is translated into mathematical symbols ready for copying to the clipboard for insertion into your document.

Microsoft Experience Pack consists of six free downloadable tools that expand the Tablet PC experience. These include a crossword puzzle program, an ink art program, a media mover and a windows theme, but the best for instructional use are the Ink Desktop and the snipping tool. The Ink Desktop turns the windows desktop into a writable pad. The snipping tool is extremely useful. When selected the entire screen of the Tablet PC turns grey and a menu of tools appears at the bottom of the screen. You can select anything on the screen to be captured, use the pen tools to write on it, and then copy to clipboard, save to file or email what is captured and annotated. The snipping tool is one that can help you prepare in many ways. You might want to ‘snip’ the image of a question from an onscreen-quiz and then annotate it with the correct answer. You can send to clipboard then paste into Microsoft Journal to do a more complete answer in ink before sending it to the student that might have missed that question.

Microsoft Power Toys for the Tablet PC include additional programs that developers create after the release of the Tablet PC Edition. There are many individual programs that you might want to try. Chief among these are the Calculator for Tablet PC and the Web Search Power Tool that allows you to ink your search. Both the education and experience packs as well as the Tablet PC Power Toys can be downloaded at

<http://www.microsoft.com/windowsxp/tabletpc/>.

### How to keep up to date with the technology

It isn’t easy, but there are some great sites to visit regularly to see what is new in the Tablet PC world. Microsoft runs an expert zone and it can be accessed at

<http://www.microsoft.com/windowsxp/expertzone/communities/tablet.mspix>. The Student Tablet PC blog is among the best for all things about tablets in the academic world. (See <http://thestudenttabletpc.org>.) A few others worth checking from time to time are <http://www.tabletpcbuzz.com/>, <http://TabletQuestions.com>, and <http://thetabletpc.net/>. We would also like to invite further discussion on tch-econ about mobile technology in the classroom.

### Who in Economics are using Tablet PCs in the classroom?

Table 1 lists the faculty economists that we know are using Tablet PCs in their classroom.. This list is only instructive and intended to invoke discussion. We invite other faculty using Tablet PCs in the classroom who wish to serve as resources to assist their peers to help integrate them into the classroom to contact the authors for inclusion on the list.

**Table 1: Economists Using Tablet PCs in the Classroom**

<b>Name</b>	<b>Instructor Tablet</b>	<b>Student have Tablets</b>	<b>Comment</b>
Dan Talley	X	X	
Steve Myers	X		
Mary Dixon	X	X	DyKnow, Dixon (2006)
Bob Parks	X		
Martha Olney	X		
Jim Lacey	X		
Barry Keating	X		
Richard Rogers	X		
Brian Peterson	X		
Phil Holleran	X		Holleran (2006)
Joe Santos	X		
Pierre-Olivier Gourinchas	X		

## V. Conclusion

This paper addressed the use of mobile learning technology in the teaching of economics. Specifically, we examined some of the pedagogical options that are available when instruction is delivered using an online course management tool, combined with a wireless network and the use of a Tablet PC by the instructor and students. This paper highlighted some of the exciting possibilities that are opened up by the use of this high technology environment in teaching.

We believe the use of the Tablet PC represents an evolutionary leap forward in computer assisted instruction. The features of the Tablet PC, especially the digital ink capability with its natural uses in economic instruction, when combined with existing wireless technologies and supporting software tools can create a mobile learning environment inside and outside the classroom that offers the opportunity to significantly enhance student learning and engagement. In particular, we believe that active learning and collaborative curriculum changes will be able to be more efficiently made by instructors as they take advantage of the features. The combination of greater efficiency in the use of instructor time and improved pedagogy inside and outside the classroom offers the potential for great improvement in student learning and engagement.

We encourage the profession to continue to assess and evaluate the use of Tablet PCs for use in instruction. We look forward to the formal assessment of the impact of Tablet PCs on student learning and engagement and its impact on the efficiency of the instructor as a natural course of further research in this area.

## Looking Beyond the Whiz-bang Technology – Mobile Learning Technologies

### References

- Agarwal, R., and A. E. Day. 1998. The impact of the Internet on economic education. *Journal of Economic Education* 29 (Spring): 99-110.
- Alverdo, C., R. Anderson, R. Anderson, J. Prey, B. Simon, J. Tront, and S. Wolfman. 2004. Tablet PC and Computing Curriculum, Microsoft Research, MSR-TR-2005-99, March, 14 p.
- Anderson and J. Prey. 2005. Conclusions from the University of Washington and Microsoft Research 2005 Faculty Tablet PC Workshop. Available at <http://www.cs.washington.edu/homes/anderson/tpc/documents05/Summary2005.doc> (accessed January 3, 2007). 10p.
- Angelo, Thomas and P. Cross, 1993. *Classroom Assessment Techniques: A Handbook for College Teachers*, 2<sup>nd</sup> Edition: Jossey-Bass.
- Aplia. 2004. *What is Aplia?* Retrieved June 5, 2004 from <http://www.aplia.com/index.jsp>.
- Ball, S. and C. Eckel. 2004. Using technology to facilitate active learning in economics through experiments. *Social Science Computer Review* 22 (Winter): 469-478.
- Becker, W.E. 2000. Teaching economics in the 21st century. *Journal of Economic Perspectives* 14 (Winter): 109-119.
- Becker, W.E. 2003. Teaching Quantitative Methods in Economics: Alternatives to Theorem and Proof and Chalk and Talk, University of Évora, February 20.
- Becker, W. E. and M. Watts. 1996. Chalk and talk: A national survey on teaching undergraduate economics. *American Economic Review* 86 (May): 448-53.
- Becker, W. E. and M. Watts., eds. 1998. *Teaching Economics to Undergraduates: Alternatives to Chalk and Talk*. Cheltenham UK: Edward Elgar.
- Berque, D., J. C. Prey, R. H. Reed. (eds.) 2006. *The Impact of Tablet PCs and Pen-based Technology on Education: Vignettes, Evaluations, and Future Directions*, Purdue University Press, 200p.
- Boylan, M. 2004. What have we learned from 15 years of supporting the development of innovative teaching technology? *Social Science Computer Review* 22 (Winter): 405-425.
- Chizmar, J. F., and A. Ostrosky. 1998. The one-minute paper: Some empirical findings *Journal of Economic Education* 29 (Winter): 3-10.
- Clark, C. and Keating, B. 2004. Notre Dame Tablet PC Initiative. Presented to Teaching and Learning with Technology Conference, Purdue, April 14.
- Daniel, J. 1999. Using the Web to improve computer-aided instruction in economics. *Journal of Economic Education* 30 (Summer): 225-43.
- Dixon, M. P. E., M. T. Villinski, and K Pannell. 2006. From “Chalk and Talk” to Animate and Collaborate: DyKnow-Mite Applications of Pen-based Instruction in Economics in *The Impact of Tablet PCs and Pen-based Technology on Education: Vignettes, Evaluations, and Future Directions*, Purdue University Press.

## Looking Beyond the Whiz-bang Technology – Mobile Learning Technologies

- Greenlaw, S. and E. Elzer. 2007. Using Wikis to Empower Student Learning in Seminar Courses, presented to ASSA meetings, Chicago, January 7.
- Holleran, P. 2006. The Impact of Tablet PC Presentation on Student Learning in Introductory Macroeconomics. Unpublished manuscript received from the author Nov. 6, 2006.
- Hubbard, J. 2006. Use of Pen-based Technology in Calculus Courses in *The Impact of Tablet PCs and Pen-based Technology on Education: Vignettes, Evaluations, and Future Directions*, Purdue University Press.
- Manning, L. 1996. Economics on the Internet: Electronic mail in the classroom. *Journal of Economic Education* 27 (Summer): 201-04.
- Mateer, D. 2006. Economics in the Movies by G. Dirk Mateer. Retrieved Dec. 28, 2006 from <http://economicsinthemovies.swlearning.com/>.
- Myers, Steven C. (2004a) Six uses of Technology to Improve Teaching and Learning, CEE/AEA poster Session on Active Learning Techniques, ASSA meetings, San Diego, January 4. Available at [http://gozips.uakron.edu/~myers/online/ASSA2004/Myers\\_Poster\\_Six\\_Uses\\_of\\_Technology.pdf](http://gozips.uakron.edu/~myers/online/ASSA2004/Myers_Poster_Six_Uses_of_Technology.pdf).
- Myers (2004b) January Case study: Digital Pen Technology in Lecture Presentations. [http://www.economicnetwork.ac.uk/showcase/myers\\_presentations.htm](http://www.economicnetwork.ac.uk/showcase/myers_presentations.htm) (accessed January 3, 2007).
- Myers, S. 2005a. “Digital Ink and the Teaching of Economics and Statistics” presented to the Robert Morris Conference on Teaching Economics: Instruction and Classroom Based Research, Moon Valley PA (February).
- Myers, S. 2005b. “Electronic Grading Using Digital Ink Technology” keynote address, multi-college workshop on Encouraging Writing in Quantitatively Demanding Disciplines, Bryn Mawr College (June).
- Porter, T., T. Riley, and R. Ruffer. 2004. A review of the use of simulations in teaching economics. *Social Science Computer Review* 22 (Winter): 426-443.
- Parks, R. P. 1999. Macro Principles, PowerPoint, and the Internet: Four Years of the Good, the Bad, and the Ugly. *Journal of Economic Education* 30 (Summer): 200-09.
- Renna and Ghosh (2005) Technology in Support of Good Pedagogy: Electronic Response Systems and Conceptests in an Economics Classroom, in draft.
- Simkins, S. P. 1999. Promoting active-student learning using the World Wide Web in economics courses. *Journal of Economic Education* 30 (Summer): 278-87.
- Sosin, K., B. Blecha, R. Agarwal, R. Bartlett, and J. Daniel. 2004. Efficiency in the use of technology in economic education: Some preliminary results. *American Economic Review* 94 (May): 253-258.
- Thede, S. M. 2006. Using DyKnowVision Software and Pen-Enabled Computers to Increase Class Participation. Presented at Workshop on the Impact of Pen-based Technology on Education, Purdue, April 2006.
- Twining, P. 2002. Enhancing the Impact of Investments in Educational ICT at <http://kn.open.ac.uk/public/document.cfm?documentid=2515> (Accessed 30 March 2005).