Chalkboards No More: Technology That Radically Changes the Classroom
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Abstract
Grove City College (GCC), a private, highly selective, liberal arts institution with a student population of approximately 2500 students, located in Pennsylvania, has had a 1:1 mandated mobile computer student program since 1994. To begin the second decade of the mobile computing program, the Class of 2008 was the first class to receive a Tablet PC. With the advent of powerful, highly functional and reliable Tablet PCs, the college has been supplying freshmen with HP Tablet PCs over the past three years. Currently, there are more than 1900 Tablet PCs on campus. In this paper, we describe the principles of the mobile computer program, how the program lays the foundation to deploy, in an adaptive and comprehensive fashion, new technologies that we believe radically change the traditional classroom, and how these technologies are used.

Foundation and direction
Beginning in the fall of 1994, every incoming freshman at GCC received a laptop computer and printer as part of the College’s Information Technology Initiative. The initial principles behind the initiative were:

1. to prepare students for excellence in their chosen profession by providing the necessary technological tools and instruction;
2. to recognize, in a tangible manner, the fact that state-of-the-art computing is moving away from centralized computing and rapidly toward distributed computing facilities following the concept of anytime/anywhere learning;
3. to provide a level of convenience for students by increasing the technological resources available to them on campus while reducing the total cost of technology ownership to the College; and,
4. to centralize all support activities including the computer help desk, training and repair shop staff.

Although laptops are used heavily by students, the primary use was seen outside of the classroom to complete assignments using various software packages, as well as gaining access to electronic content through databases, the Web, and so forth. In the classroom, the majority of students, especially in the science and engineering disciplines, continued to take notes with pen and paper due mainly to the type of content that was being delivered. In 2004, as we began our second decade of the mobile computing program, we decided it was time once again to set the stage for
a new direction where the utility of technology could be harnessed to a greater extent inside the classroom for both faculty to teach and students to learn. Therefore, we began to distribute Tablet PC computers and printer/copier/scanning devices to provide a somewhat more natural and adaptive technology.

Through our successful, long-term partnership with Hewlett-Packard, the Tablet PC platform was given to all incoming students of the Class of 2008. We continue to provide freshmen with Tablet PCs. The Tablet PC combines the best of a laptop and the ability to write on a streamlined mobile device. For faculty this essentially means that adoption of technology is less revolutionary but evolutionary as the platform extends the delivery method with which many faculty have a significant comfort zone: writing.

The stylus is not merely a pointing device, rather it enhances the ability to draw attention to and deliver information in a more meaningful manner using a variety of applications. The stylus and pen-aware programs, such as Microsoft® Word and OneNote™, allow students from any discipline to use the Tablet PC in the classroom to take notes and participate in classroom activities. The Tablet PC helps students become better organized by allowing notes to be automatically indexed by desktop search engines. Most importantly, the Tablet PC allows the student to use the modality with which he or she feels most comfortable: typist, writer or a combination of both.

It is easy to include a variety of material, such as photographs and screenshots into notes. Thus, a student can construct a comprehensive set of notes from an array of information sources in a variety of formats.

Bringing technology on the campus that directly supports the educational mission, both in and outside of the classroom, keeps the College’s mobile computer program vital both inside and outside the classroom. More importantly, however, the program allows faculty and students to create new ways to enrich the classroom experience and scholarship on campus.

**Standardize and ease the life of students and faculty**

To create a managed environment, maximize the potential of technology and provide digital unity, standardization of both platform and software is necessary. Standardization helps in keeping the total cost of ownership down, because the cost per unit can be more favorable due to economy of scale, and support becomes more streamlined as the need for repairs are limited to select models from a single vendor.

An HP Tablet PC and HP all-in-one printer is provided to the incoming students, as well as faculty. We standardize on a specific model as well as provide campus wide software agreements for a host of applications. Today the breakdown of the computer models on campus is:

- Class of 2007 – Compaq EVO N620c;
- Class of 2008 – HP tc1100 Tablet PC, HP;
- Class of 2009 – HP tc4200 Tablet PC;

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Faculty machines are replaced every four years, and they receive the same models as the freshmen students for that year. Those faculty eligible for new machines this year received an HP tc4400 Tablet PC, external Multibay DVD/CD-RW plus docking station, external monitor, keyboard and optical mouse. This configuration allows a faculty member to have the best of desktop and mobile computing.

Standardization also encompasses our multimedia classrooms. These are also on a four or five year upgrade schedule, and every effort is made to provide the same functionality using the same equipment in similar classrooms across the campus. By capacity and location, we equip multimedia classrooms with the same podium, podium controls, computer and ancillary equipment. The programming of the control systems for each podium is consistent so faculty can be scheduled in multiple classrooms without having to learn multiple systems.

Multimedia podiums, available in approximately 40 classrooms, have desktop PCs, AM/FM/cable TV tuners, document cameras, DVD and video tape players, projectors and mechanized projection screens. These podiums also support connections from external computers, so the Tablet PCs can drive the projectors.

Approximately 75% of the classrooms on campus are equipped with network ports and electrical outlets at each seat. All classrooms have connectivity for the lecturer and many classrooms also have wireless access. In total, there are approximately 7,100 hardwired network ports including the residence halls were there is a port-per-pillow. The backbone is all fiber connected running at gigabit speeds with multiple trunks to each of the academic buildings. The network electronics in place are wire-speed, non-blocking HP ProCurve Switches. The campus network has ample bandwidth with capacity to grow in the future. In addition, all students and faculty have networked disk space that is available from any network connection on campus.

Standardization also encompasses software. Having site license agreements, such as the Microsoft® Campus Agreement, allows both the faculty and students to work in the same software suites and provides streamlined upgrades to all constituents.

The end results are a great benefit to both students and faculty in that everyone on campus shares a common hardware and software platform. With campus-wide licensing of productivity tools (Microsoft® Office), programming environments (Visual Studio and Metroworks), engineering software (ProE and ProMechanica), mathematical software (MATLAB and Mathematica®), as well software for lab instrumentation, faculty can be sure that students have the tools for their assignments; students have the advantage of mastering a single set of tools that serves them throughout their time at the GCC. Delivery of lectures, assignments, notes, and other materials is greatly simplified. In addition, the College uses common course-management systems (Blackboard/WebCT and JICS-LMS).

As another example, in the Computer Science Department, has standardized on Visual Studio 2005, which makes classroom presentations more effective, since faculty can demonstrate how to perform various tasks in Visual Studio and Windows knowing it will apply to all students. Not so in a classroom with a variety of operating systems and programming environments: what
works for Visual Studio does not necessarily work for Gnu c++, and what works on a Mac does not always work the same way on Linux, and so forth. Moreover, when a student needs help with a program, faculty can concentrate on the program knowing that the environment is consistent; he or she does not have to spend time figuring out idiosyncratic environment setups on a multitude of operating systems and development environments.

With digital unity and the integration of technology into the curriculum - not solely for the sake of technology, but to provide a common set of tools for the enhanced collection, creation and delivery of content and foundation for an adaptive collaborative/immersive teaching and learning environment - the use of the technology today is pervasive throughout campus.

Standardization, however, does not come without cost. Since we are tightly partnered with HP and the Windows environment, we must follow their technology roadmaps. This sometimes makes it hard to take advantage of either hardware or software innovations that occur outside these two companies. In addition, some faculty and students prefer to work in a different environment for a variety of reasons. Where necessary, these students and faculty are accommodated by providing the necessary hardware and software. For example computer-science students must be exposed to different operating systems and development environments. We are able to do this by maintaining a number of Linux machines, and in some classes we also provide Freescale Metrowerks development systems.

We strongly believe that digital unity and standardization bring more benefits than problems and to a great degree lead to more efficient operation and overall simplify faculty and student life. In addition, we have developed significant knowledge within the college of how the hardware and software systems operate, making maintenance and support easier. Interestingly, standardizing the hardware and software platforms helps students collaborate with each other.

**Classroom technologies**

While great technology has the potential to make life easier, we believe we are on the cusp of a radical change in the use of technology in the classroom. The College, in partnership with Carnegie Mellon University, has recently started an initiative to more fully exploit the potential of Tablet PCs to drive pedagogy through the support of the Microsoft® Research Tablet PC initiative.

While computer-based slides are common in lectures, often times they have done little more than add color and hide the bad handwriting of professors writing on blackboards. They provide similar information as a blackboard lecture in a static unidirectional manner and do little to make lectures more interactive.

New Tablet PC-based technologies, such as DyKnow® Software (Vision and Monitor), Classroom Presenter, and Microsoft® Research ConferenceXP make a substantial change to classroom interaction. We collectively call these classroom-management systems. We have deployed DyKnow® Software to 39 classes with 17 faculty and approximately 800 students. DyKnow is an integrated solution that brings together collaborative note taking, classroom interaction, computer monitoring, and after class activities. These courses cover a broad range of departments at the college, from engineering and science to the humanities.
Classroom-management technologies empower the lecturer to deliver his or her presentation directly to the students Tablet PCs in real-time. Gone are the days when faculty had to deliver PowerPoint via network folders or email before or after class. The lecture can be based on prepared notes (such as PowerPoint) or written in real-time by the lecturer. Since the lecturer is using a pen, he or she is free to write, sketch, use symbols, write equations, and so forth as on a blackboard, yet the material is captured on the student’s machine immediately. For example, see Figure 1.

Figure 1: DyKnow screenshot showing a PowerPoint slide with lectures notes (view from lecturer’s perspective).

The students can write personalized notes in real-time on the lecture material directly on the delivered slide or in a private “notebook” (see Figure 2). These systems also allow the student to easily and privately provide feedback on the level of their understanding of the material while it is being presented, ask the instructor questions through a participant-to-moderator chat, and also capture course content not only from the lecturer, but through slides submitted by other classmates that the lecturer may make available. It allows for interactive and collaborative teaching and learning while providing a means of classroom management.
For example, in Figure 3 we show a slide returned from a student to the lecturer during a computer-science class. In class, the lecturer was describing a sorting algorithm. He then wrote out a small array of numbers (top line, in blue) and asked all the students to show the steps the sorting algorithm would execute on that array. All the students in class completed the *impromptu* exercise and returned their panels. The student’s work on this panel is shown in lines two and three (in purple). By scanning the returned panels as they were submitted, the lecturer was able to determine that the class understood the topic, and he was able to move on. This type of interaction is very difficult to accomplish without tools like DyKnow.

Outside of class, the student has the ability to replay the slides and watch the information delivered exactly as it was in the classroom and add additional notes or references providing a powerful tool for review and exam preparation.

For better or worse, students need not even be in the classroom. They can join DyKnow sessions from anywhere they have a network connection, such as their rooms. Similarly, traveling faculty can deliver lectures in real-time while on the road. This technology also makes it possible for us to conduct a pilot distance education course where twelve of our Mechanical Engineering students traveled to Nantes, France, and took two Mechanical Engineering Courses as it was being taught to their fellow classmates on campus.

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The nature of assignments has also changed. Since our students have Tablet PCs, we no longer collect paper copies of assignments. Students are expected to write solutions using applications such as Microsoft® Journal, Microsoft® OneNote™ or Microsoft® Word and upload these to a course-management system or protected network folders. Even homework with complex mathematics and drawings can be done using this approach.

There are several advantages to this method:

1) we can more easily manage the assignments and keep records for things such as accreditation;

2) we mark the assignment electronically, so that we have our own record of the grade, which is particularly helpful when students email or message questions about their work; and,

3) the student has his or her own copy of the assignment in case it gets lost or is needed for other work. We are currently investigating and plan to implement a similar mechanism for taking examinations.

Figure 3: Panel returned to lecturer from student.
The Tablet PC allows students to complete their assignments more conveniently. Since the assignments are written on a computer with all the necessary information and tools at hand to complete them, students can work on assignments anywhere on or off campus. A benefit of this is that it reduces the amount of space needed for dedicated computer labs and related facilities.

Summary

Over the past thirteen years, GCC has employed technology to support education and scholarly activity. The campus is supported by ubiquitous networking, a plethora of software to support education across the College, and Tablet PCs in the hands of almost every faculty member and student.

The College has seen technology move from making life more convenient for students and faculty to fundamentally changing the way we educate our students and the way we work. The combination of powerful Tablet PCs, networking and software that take advantage of both of these technologies offers new opportunities for faculty and students to interact in and outside the classroom.

We have started to see significant changes in how many of the lectures are delivered on our campus. Faculty are using DyKnow to increase interaction in the classroom, and get a sense of student understanding by giving in-class exercises. Students are accessing notes after class (as measured by the load on the Dyknow server and student comments during office hours). We have even seen that many faculty, even those dedicated to using chalkboards, are giving them up in favor of Tablet PCs and classroom management systems.

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1 Inman, John G. “Information Technology Initiative Comes of Age at Grove City College”, The Technology Source, January 1998.
2 Jenny, Frederick J. “A Decade of Mobile Computing for Students”, In Proceedings for the 2005 ASCUE Conference (Myrtle Beach, South Carolina, USA June 12-16, 2005).
3 http://www.dyknow.com
5 http://www.cs.washington.edu/education/dl/presenter
6 http://research.microsoft.com/conferencexp
8 Including one of the authors.