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BMB Teaching Initiative: Enhancing large-enrollment science courses through inking, capture and wireless technology

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1) Summary

We set out to enhance large-enrollment lecture courses by training ourselves in novel teaching styles made possible by tablet, wireless and screen casting technologies. We used funds awarded from the President's Office to purchase hardware and provide support for up to six concurrent technology-enhanced courses. The project was highly successful, with

- over 1000 students taught,
- ten faculty members from three departments transforming their courses,
- lessons learned made publically available through a wiki,
- results presented at two conferences, and
- steps taken to expand this initiative across departmental boundaries.

Both students and teachers were enthusiastic about how the technology had enhanced their experience. Upon completion of the project, additional funding from the College of Natural Sciences and Mathematics enabled the Chemistry department to purchase twelve tablets for introduction into their large-enrollment courses.

2) Objectives and strategies

Our task for this Professional Development initiative was to train and support faculty in their use of tablet-based teaching technology, and to assess what worked and what needs further development. Our goal was to enhance large-enrollment science courses taught to our undergraduate students and, through dissemination of resources and lessons learned, courses taught across the University. This strategic initiative for our entire department made use of synergies and ideas emerging from exploring a new set of tools together.

3) Activities carried out

We purchased four tablet PCs and installed a comprehensive package of software. For teachers used to teaching with a Macintosh, we additionally purchased two wireless input panels and software for the Macintosh, providing a similar set of tools on a second platform. During the

first summer workshop, we trained faculty to use the unique pen-based capabilities of the tablets. During the second summer workshop, faculty presented their plans for teaching with the tablets, and local experts Rich Rogers (Resource Economics) and Heath Hatch (Physics) were present to give feedback.

Table 1 shows courses taught during the academic year, their enrollment and instructors. In the fall 2007 semester, five faculty in the department taught tablet-enhanced courses after training during the summer. Although each instructor had different goals and used a different combination of tools, they all felt the technology enhanced learning outcomes, and they did not switch back to their "old method". In the spring 2008 semester, four additional faculty members from three departments joined the initiative after a brief overview of the technology at a workshop during intersession. Newcomers were paired with faculty having taught in the fall to quickly help out should pressing issues arise. The last two courses are not large-enrollment undergraduate courses; in these courses, we explored alternative uses of tablet technology such as electronic grading and leading discussions after scientific talks.

Course	**Enrollment**	**Instructor**	**Term**
Biochemistry 523	78	Scott Garman	Fall 07 part 1
		Jennifer Normanly	Fall 07 part 2
Biochemistry 471	77	Dave Gross	Fall 07
Chemistry 112	177	Alejandro Heuck	Fall 07
Biology 285	217	Dan Chase	Fall 07
Biochemistry 524	66	Alice Cheung	Spring 08 part 1
		Frieda Reichsmann	Spring 08 part 2
Biology 285	189	Dan Chase	Spring 08 part 1
		Abbie Jensen (Bio)	Spring 08 part 2
Chemistry 112	181	Jeanne Hardy (Chem)	Spring 08
*Biochemistry H01	22	Karsten Theis	Spring 08
*Drug design	26	Scott Garman	Spring 08

Instructors were responsible for assessing student attitudes about the changes made in the course. In four cases, the Center for Teaching conducted a so-called midterm assessment program, with students asked a mix of general and technology-specific questions on teaching quality. To obtain data on the instructor's view of the new technology, two questionnaires were developed, one to be completed before teaching the course and one after. These consisted of specific questions on techniques and software used during the course, and open-ended questions allowing instructors to comment on how the technology helped them to reach their teaching goals.

4) Deliverables

In a nutshell, deliverables were a) to introduce new teaching technology in our department to improve student learning, and b) to disseminate the lessons learned and tools developed so that other faculty at the University could introduce similar pedagogy in their courses. Both deliverables were met. Indicators of success in enhancing our courses are summarized in section 5. Dissemination was achieved through four channels:

- Word of mouth on campus
- Video presentation (http://blogs.umass.edu/teachoit/2008/04, bottom of the page)
- Web site: http://www.biochem.umass.edu/BMBTI/
- Presentations at two conferences
    - UMass Instructional Technology Conference: The Scholarship of Teaching & Learning: Making IT Matter, April 11, 2008, Boxborough, MA
    - "Best Practices for Science Education: Retaining Science and Engineering Undergraduates, Sustaining the Science and Engineering Workforce," June 24, 2008, Amherst, MA

5) Assessment

Student response to technology was assessed through the Center of Teaching. Results from multiple choice questions indicated that students were enthusiastic about the inking technology, slides posted on the class web sites and, most emphatically, audio and video of the lectures posted for later review. Responding to open-ended questions about what students liked, the step-by-step nature of inking, its effect on the pace of the lecture and its visibility were praised. Examples of student comments are "I like the inking a lot. It helps to see it done out in front of me", "Inking is much esier to see than work done on the chalkboard", "I like how he writes everything down with the stylus pen; and he doesn't assume that we know the little steps". While inking technology was used in every single course, screen casting was not used universally; however, in classes with screen casts made available on the web, students found these very helpful to review material covered in class, as a substitute for lectures missed (e.g. a single mom had to take care of her child and missed one of the lectures), and as a way for students with English as a second language to overcome the language hurdle.

Instructors were queried with a pre- and post-teaching questionnaire, and there was time for informal exchange throughout the academic year. Most of us were pleased with the ease of interacting with our students through inking, and also were well aware of its role in slowing down our pace. Inking was easier on the tablet PC than on the wireless input panels; however, some Macintosh users were willing to have a slightly more cumbersome inking experience in exchange for being able to teach with their own computers. Instructors who prepared screen casts of their lectures found the process to take a moderate amount of time (10-20 min after every class), and the main challenge was not to forget to start the recording at the beginning of class. One instructor commented that pre-class setup becomes quite difficult without a teaching assistant, juggling to prepare live chemistry demonstrations, to start up the Personal Response System, and to make sure all software (powerpoint, Camtasia for recording, PRS software, and any other software used during the class session) is up and running. One motivation for this project was to combine inking with PRS; this proved difficult during the fall semester because of software compatibility issues, which were resolved by the spring semester through a software upgrade. Wireless was not used extensively because it was not available in all class rooms, and instructors were hesitant to be dependent on internet access. In response, we provided tools to have local copies of essential material from the web. These issues are discussed further in the following section.

6) Issues and future work

Issues that came up during the initiative are discussed in detail on the project web site, and tools and tutorials developed specifically to address them are collected there as well. Here, I will comment on selected points.

A) PRS/powerpoint problem. We installed the newest powerpoint version, 2008, on the tablet PCs, only to find that it was not compatible with the current PRS software. This caused a lot of headache in the fall courses, with one instructor moving all PRS questions to the end of the class period, and another bringing in two computers to run the two programs without interference. As a result, we could not focus as much as we wanted to on how to integrate inking and PRS. This problem was resolved by the spring term, during which courses could be taught with PRS questions directly inserted into powerpoint presentations, as originally envisioned.

B) Wireless input tablets. While the fall term instructors were convinced of the value of the new technology, some of the spring term instructors became frustrated with the technology and did not use it regularly. It should be pointed out that three of them used the wireless input tablet to teach with their own Macintosh computer. The wireless tablets allow inking, but does not give feedback on the writing surface; instead, one has to look at the projected image while writing on the tablet. Two additional strikes were the lack of preparation time during intersession and power outages in Lederle. As a consequence, some instructors decided to defer introduction of the technology.

C) Wireless microphone. Recording lectures while teaching with the wireless input tablets resulted in inferior sound quality because the instructor was often far away from the computer's microphone. Students had no difficulty understanding the instructor in class, but noticed that the recordings were almost inaudible. This problem was solved by purchasing and using a wireless USB microphone (WIFI-based).

D) Wireless internet access. Some lecture halls in chemistry had no wireless access, and we were not successful in arranging access before the start of the academic year. In rooms that did have access, some instructors were hesitant nonetheless to include web-based tools and electronic literature in their courses because they did felt they could not trust internet access. Three work-arounds were tested. 1) Store a local copy of the web sites on the computer using the scrap book add-on to the firefox browser or similar software. 2) Record a demonstration with Camtasia in advance and play it back in class. 3) Use a wireless projection gadget that plugs into the wired network for wireless internet access. While these all have some drawbacks, they can be used as a backup for live, wireless connection to the internet in class rooms that have access.

E) Wireless projection. Instructors using the wireless input pads enjoyed the freedom from teaching anywhere in the class room, something not available to instructors inking directly on a tablet PC. Some class rooms have the projection screen above the position of the computer, making it impossible to see the screen while operating the computer. Halfway into the fall semester, we decided to purchase a wireless projection gadget. It connects by wire to the projector, and communicates wirelessly with the computer. The range of the wireless connection (WIFI-based) is larger than for Bluetooth technology, enabling the instructor to teach from anywhere in class (and to turn over the computer to a student if desired). For

group work where every group has access to a computer, groups can quickly swap access the projection screen without the need for cumbersome switching of connections.

F) **Smooth switching between tools and software.** Experience with introducing PRS to courses showed that both instructors and students loose enthusiasm for technology when setting it up or troubleshooting it takes away from class time. We would like to ink in different colors, add blank slides, demonstrate software and internet tools in class, but if this is cumbersome and time-consuming, it will distract from the lessons. We assembled a set of macros that makes it easy to ink in powerpoint and to switch in and out of powerpoint. The macros are available from the initiative's web site, along with a tutorial how to use them.

G) **Maintenance of tablet program.** In conducting this initiative, it was vital to have a running budget to address some of the issues we encountered through purchase of additional software or hardware. Now that the year is completed, it is not clear how we will maintain the equipment we have used so successfully in the past year. For instance, there is no mechanism in place to fund potential repair costs. Moreover, there is no mechanism to ensure that new faculty will be trained (other than the commitment and good will of individuals who participated and feel strongly about the value of continuing to develop this teaching style).

7) Disposition of funds

- Hardware: $9065 (4 Tablet PCs, 2 wireless input tablets, accessories)
- Software: $1576
- Summer salary for the PI to support summer workshops: $1000
- Undergraduate assistant: $359

8) Final thoughts

While hands-on training in laboratory techniques will always rely on small group work with a high instructor to student ratio, the intellectual preparation for laboratory research can be effective in a large class room when supported by sufficient TAs and technologies such as the ones explored in this initiative. This was a timely initiative because on the one hand, tablet PCs have matured into powerful tools that are easy to use and on the other hand, more and more of a scientist's work is through electronic media, publically available databases, tools and research literature. To bring authentic science to the students, it is no longer necessary to tour the library, visit a computer lab or look at slides or specimens in a collection, but much of it is available from a standard computer. However, there is a great need to teach the scientists of tomorrow how to navigate this wealth of information, how to draw conclusions from it, and how to design experiments to answer tomorrow's questions. The combination of accessing scientific data in the classroom (through wireless connection), teaching how to work with that data (by solving problems step-by-step with electronic inking technology), and recording these sessions as screen casts for later review gives a much richer experience for students than learning from textbooks and lectures only. Moreover, even in large classes we can provide opportunities for students to practice their problem solving skills (through assignments in class polled by PRS or administered online), and the technologies explored here allow teachers to address questions as they arise while students actively learn in the classroom.