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POINTS OF
CONNECTIVITY

By Sarah E. Smith and Anthony Potoczniak

New advances in technology, particularly in the area of higher education, provide instructors with more opportunities to engage students in the learning process. However, utilizing technology to promote learning in the classroom can be a double-edged sword. If properly implemented, technology can enhance students' learning experiences, thus improving students' mastery of the course material. But if used excessively, technology can cause passive behavior toward the subject and impede the learning process. As graduate students who have recently experienced both sides of the lectern, we would like to share our perspectives of how technology can help improve learning in the classroom.[1]

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During the process of designing a course, the instructor first should reflect on the course from the students' perspective by evaluating the goals of the course. What is the overall goal of the class? What does the instructor want the students to learn? The instructor should focus on the learning goals instead of the teaching goals.

Second, the instructor needs to consider the objectives of the students' interaction with the course content. How should the content be delivered? Should the course content be delivered solely through lectures? Should it be made available on the Web? Should students interact with the content via some type of specialized tool on a Web portal? Based on the goals, the desired learning environment, and the specific course content, what technologies should be incorporated into the lecture to stimulate learning?

Finally, the instructor should think about how technology can help students to actively engage the objectives of the course. How can the instructor push the students to take projects as their own? How can students get involved in enhancing the learning process through technology and in extending the capabilities of technology? How can students be motivated to solve life's mysteries using technology?

The Technologies and Connectivity

Several technologies—some currently being used in the classroom and some just beginning to emerge—can play important roles in improving learning:

- *Blogging.* "Blog" is short for "Web log." Blogs are diary-like Web publications about a variety of subjects (personal, educational, technological, political, etc.). Many blogging applications allow for reader feedback and comments on a blogger's post.[2]
- *Clickers.* Clickers, similar to TV remote-controls, provide a signal transmitting a student's response to a question that an instructor posts.[3]
- *Courseware.* Courseware is software that helps with the management of a course. Courseware platforms include Blackboard (http://www.blackboard.com/), WebCT (http://www.webct.com/), OpenSeminar

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(http://openseminar.org/), and Connexions (http://cnx.rice.edu/).

- *Course Web Sites.* Many colleges and universities provide Web space for their instructors to create Web sites with course information such as the syllabus, course schedule, notes, and resources.
- *Croquet.* Croquet (http://www.open croquet.org/) is a 3-D collaborative, network environment in which users can meet and work together in a virtual world.
- *del.icio.us.* del.icio.us (http://del.icio.us/) is social bookmarking software that allows users to create a collection of Internet bookmarks, categorize their bookmarks, and share bookmarks with others.
- *E-portfolios.* E-portfolios are a way for students and instructors to keep track of and share their progress and achievements.[4]
- *Flickr.* Flickr (http://www.flickr.com/) is a photo-sharing technology that allows users to add tags and notes to organize their photos. Other users are able to comment on photos.
- *Message Boards and News Groups.* Message boards and news groups are Internet forums that allow users to post relevant information and to comment on the information.
- *Podcasting and Vodcasting.* Podcasting is the downloading of audio files about various subjects directly to an MP3 player.[5] Vodcasting is the same as podcasting except that video files are downloaded instead of audio files.
- *PowerPoint.* PowerPoint is often used to highlight the main points of a lecture or presentation. Microsoft offers the software as part of the Microsoft Office suite of products.
- *Webcasts.* Webcasts are online seminars that are conducted through some type of software. Most Webcasts allow for PowerPoint presentations, chat, audio, and video. Webcasts are conducted live at a particular time and are archived for later viewing.
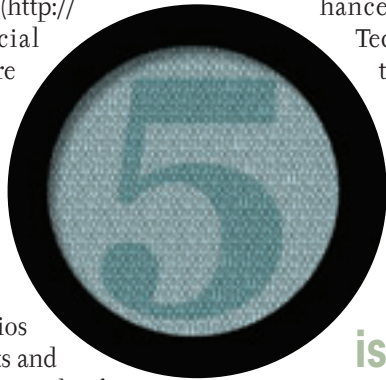
- *Wikis.* A wiki is a Web authoring tool that allows for editing within the Web browser window. Most wikis allow anyone to edit content, using an honor system. The most popular wiki is *Wikipedia* (http://wikipedia.org/).[6]

The key to using any technology successfully in a classroom setting is through connectivity. By *connectivity,* we mean the students' and instructors' ability to engage with the course materials in novel ways using technology to enhance the learning process. Technology cannot substitute for face-to-face interaction in the classroom, in the lecture hall, or during a seminar.

technologies can be grouped into one-to-one, one-to-many, and many-to-many forms of communication:

- One-to-one technologies: e-mail, instant messaging
- One-to-many technologies: PowerPoint, news groups, message boards
- Many-to-many technologies: chat rooms, wikis, Webcasts

Traditional educational practices give greater emphasis to monologic delivery or one-way communication of information from instructors to their students in a time-strict environment, meaning that a student can get instruction only from an instructor or a teaching assistant (TA) and only during class time or scheduled office

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However, technology-based learning tools used inside and outside the classroom can help make these traditional settings more productive, meaningful, and efficient for students and teachers alike. If used prudently, technology will create a stimulating learning environment and will allow students to achieve course goals.

Five components of connectivity are necessary for successfully implementing technology in a classroom and for promoting a stimulating learning environment. These are what we call the *five points of connectivity:* communication, collaboration, motivation, integration, and creativity.

Communication
Technology should facilitate communication between students and their instructor(s) and between students and their peers. Generally, communication

hours. However, learning is most productive when it can be dialogic and when all classroom participants are involved. Although total class participation is difficult in many classroom situations, certain technologies allow this communication to be organized, searchable, instantaneous, and flexible, providing students with the opportunity to ask a question or to start or continue a conversation about a topic at almost any time, outside the classroom.

Incorporating certain technologies into a classroom environment will require the instructor to adopt new modes of instruction that will encourage dialogue about the subject. In other words, the role of the instructor (or TA) in these kinds of open forums will be transformed from that of lecturer to that of virtual discussant or moderator who helps students engage the course material within a group environment.

Communication technologies easily divide into two distinct groups: technologies that are used inside the classroom and technologies that are used outside the classroom.

Inside the Classroom

The most common communication technologies found inside the classroom are audio and/or visual in nature (e.g., PowerPoint, cassette/CD players, slide machines, clickers, and VCRs/DVDs). These tools can be used effectively to organize information and present it to students. PowerPoint slides can add graphical, audio, and visual information to a presentation. Movies or educational videos can introduce a concept or reinforce one discussed during a lecture. Clickers are becoming more prevalent in large classrooms if instructors want anonymous feedback during lectures.
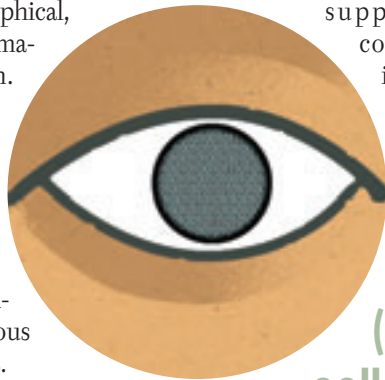
However, there are disadvantages to using each of these technologies. At a certain point, students can become disinterested in the lecture. This occurs when information is presented in the same manner for a long duration. Showing a movie during class time, for example, can appear to students as an "off-day." Although PowerPoint slides are effective tools used to reinforce the points made during a lecture, they should not *be* the lecture itself. The most egregious violators are lecturers who read their PowerPoint slides too quickly for students to take notes.

Outside the Classroom

The most common communication technologies that students use outside the classroom are course Web sites, e-mail, and message boards. Most course management software allows for these types of interactions between students and their instructor and between students and their peers. A course Web site will contain relevant class information (e.g., syllabus, project due dates, test dates, lecture notes) for students to refer to throughout the semester. E-mail can be used by instructors to inform students about schedule changes, to make announcements, and to communicate other information relevant to the course. Students use e-mail to ask questions, report problems, provide feedback, and arrange meetings. Message boards allow for discussions that an entire class can observe and participate in and can be very valuable both to students and to TAs who need to answer students' questions about assignments. Anonymous posting allows students to provide feedback about the course and the instruction to the instructing team.

Thus, technology is useful when it supports more efficient, convenient, and reliable information transfer between students and instructors.

Although these technologies are commonplace in course environments, students use other communication technologies to exchange information when they are not doing their coursework. The most common of these are instant messaging and news group postings. Other emerging technologies—such as chat rooms, podcasting, and blogging—are also becoming more popular. Students prefer these forms of technology because they can communicate freely with participants, add/update content, and be creative.

Collaboration

Technology should encourage not only discussion and feedback (communication) but also collaboration among the students, the TAs, and the professors—both inside and outside the classroom. Collaboration in group activities can be enhanced through tools such as instant messaging and wikis.

Wikis, which allow instructors and students to work on a topic collaboratively, have become useful within research settings. One example is a Web portal for the Anthropology Department at Rice University (http://frazer.rice.edu), which encourages specialists, faculty members, and graduate students to discuss technology. Technology and collaboration together work here at a very simple level but are effective in collecting viewpoints from all the participants. Similarly, the Rice Anthropology Department's project "Ethics and Politics of Information Technology" (http:// frazer.rice.edu/epit/epit.html) uses a Web site to document the free collaboration among students, faculty, and their research subjects. During the collaboration, students interviewed various faculty members at Rice and worked with them to come up with study questions of interest to the research group. Both the students and the faculty members transcribed the interview sessions and wrote brief commentaries on them. The collaboration added greater meaning to the subject area under study, and the process of adding commentaries provided the students with a wonderful form of learning outside a classroom setting. In addition to this Web site, wikis were used this past year by students and their instructor in an anthropology fieldwork class. This particular Internet technology was helpful during the development of semester fieldwork projects and allowed collaboration among peers to occur from various perspectives. Wikis offer a kind of

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discussion forum in which participants can learn the "why" behind the thoughts of other participants.

Collaboration may also be used as a "best practice" when learning the basics of a new technology. Pair programming is a collaboration practice used in the computer science discipline. With pair programming, students in introductory programming classes at North Carolina State University (NCSU) can work together on the same computer and the same piece of code to solve a problem. Technology has also been created to allow for remote pair programming in Sangam, an Eclipse plug-in (http://sangam.sourceforge.net/).

Motivation

Although "getting the grade" may be a source of motivation for students to use certain technologies in their work, instructors can be proactive in requiring students to learn technologies that may improve their understanding of the course material or, better yet, improve

their learning. If using a technology is a requirement to passing the class, students will use the technology, but most likely only at the default or minimal level. Most students do not have the time or patience to explore the technology beyond what is required for a course. In many cases, they are goal-oriented and want to meet the teacher's expectations with the least effort.

Instructors can use incentives, such as requiring the use of a technology in assignments. In one computer science course at Rice, the instructor designated a student to be the "note-taker." The student taking notes was required to transcribe them in LaTeX, an open source typesetting program that is popular among professional computer scientists for its high-quality production of technical and scientific documentation. The completed class notes were posted on the course Web site for other students to use. Extra credit may be another incentive for students to improve their grades while exploring or testing a new technology.

This is also an excellent way to determine if a technology should be used in future offerings of a course.

Students may be motivated as well by the instructor's own enthusiasm about the technology or by rewards received for going beyond minimum class requirements. But the most effective way to encourage students to use a technology is through a project that requires students to explore or extend a technology. For example, in the Ancient Spaces (http://www.cnrs.ubc.ca/ancientspaces/) project at the University of British Columbia, Canada, students model various ancient buildings while exploring ancient cultures. In another example, students in recent software engineering courses at NCSU were required to write a plug-in for Eclipse, an open source integrated development environment. Students were given the requirements of a plug-in (past examples are a reliability estimator and a bug tracker), but the implementation details were left to the students. Most students enjoyed this project because it

allowed them to make a "real" piece of software that they could release as open source at the end of the semester. And in the process of writing the plug-in, the students learned more about the Eclipse development environment.

Integration

Integration is a gradual process of determining which technologies are best suited for students in a particular learning environment. The content of the course should always drive the technology and not vice versa: the content cannot be a hostage of the technology. Thus, the goal for the instructor is a seamless integration of learning technologies with more traditional teaching techniques. Technology can be integral to learning the core concepts of a discipline, as in a computer programming class, or instrumental in increasing student interest in social sciences or humanities courses, as in the Ancient Spaces project. However, the integration of technology into a class should be gradual. Just as honing one's skills as a teacher requires years of experience, the proper implementation and integration of technology within the class environment takes time and patience.

The most important question instructors should ask themselves is: How does this technology improve students' ability to learn and understand the course material? Instructors should see what works and what does not work over several semesters. Often, students can offer suggestions in the form of midterm or end-of-semester surveys. Students, for the most part, do not mind trying new things, but they do not want to be overwhelmed with having to learn too many new technologies. In addition, instructors need to "practice what they preach" by understanding the technology they want students to use. Instruction in a particular technology—either in the classroom or through online resources—is essential to the adoption of the technology by students.

If technology is used in a lab outside of a lecture, integration may be achieved by bringing the two environments together. The SCALE-UP Project at NCSU (http://www.ncsu.edu/per/scaleup.html) integrates lectures and labs in introductory physics classes. Students sit with their lab groups and are taught by the instructor, but the instruction is interspersed with small lab activities that reinforce the concepts being taught. An advantage is that the lab activities are always in sync with

the lecture concepts. The instructor also benefits from observing the students as they complete the lab assignment and from listening to the students' ideas about possible new technologies that may be used in the class.

The Language Resource Center at Rice University (http://www.ruf.rice.edu/~lrc/index_flash.html) has been especially successful in helping language instructors integrate many digital technologies to help students learn foreign languages. The LRC is a state-of-the-art facility that provides a wide range of technological and traditional resources to enhance and promote the study of foreign language, literature, and culture. The center provides training workshops for all instructors to help design a language course that will maximize the learning potential of students. For example, many foreign language instructors use the LRC's online recorder (called "Wimba"), which can be used from any computer to record students speaking a foreign language, so that instructors can check students' progress in pronunciation and fluency.

Creativity

The last of the five points of connectivity is creativity. Today's technologies offer

Table 1. Technologies and the Five Points of Connectivity

TECHNOLOGY	COMMUNICATION	COLLABORATION	MOTIVATION	INTEGRATION	CREATIVITY
Blogging	■	■	■		■
Clickers	■				■
Courseware	■	■ (some)	■	■	■
Course Web Sites	■			■	■
Croquet	■	■	■		■
del.icio.us	■	■	■		■
E-Portfolios	■		■		■
Flickr	■	■			■
Message Boards and News Groups	■	■	■	■	
Podcasting and Vodcasting	■	■	■		■
PowerPoint	■			■	■
Webcasts	■	■	■		■
Wikis	■	■	■	■	■

students and instructors a myriad of choices for being creative in the classroom—from developing projects that incorporate collaboration to integrating multimedia into a presentation to make a point during a lecture. In many ways, creativity is the point of connectivity that ties together the four other points. Creativity can manifest itself at any moment during the learning process. Instructors should encourage students to become creative with the materials they teach, whether by building a virtual amphitheater using Ancient Spaces or organizing a group project using a wiki. The key point in selecting a technology for the classroom is that it should engage the students and inspire them to learn actively.

Although instructors and students often strive to be creative in their work, creativity is sometimes difficult to evaluate within the constraints of the college or university grading system. Yet an effort should be made. Along with the four other points of connectivity—communication, collaboration, motivation, and integration—creativity in the use of technology can help engage students in the course material and enhance the overall learning experience.

Conclusion

The five points of connectivity are key to the successful use of technology in the classroom, including the use of the technologies mentioned in this article: blogging, clickers, courseware, course Web sites, Croquet, del.icio.us, e-portfolios, Flickr, message boards and news groups, podcasting and vodcasting, PowerPoint, Webcasts, and wikis. Table 1 lists each of these technologies and indicates how each relates to the five points of connectivity.

We invite additions to this list of technologies. We also welcome comments on how the five points of connectivity can improve the use of technology in the classroom and, conversely, how the use of technology can enhance communication, collaboration, motivation, integration, and creativity—that is, foster connectivity and thus enhance learning—inside and outside the classroom. *e*

Notes

1. This article is based on a presentation given during a general session—"What Students Say about Emerging Practices and Learning Technology"—at the National Learning Infrastructure Initiative (now the EDUCAUSE Learning Initiative) Spring Focus Session, "Emerging Practices and Learning Technologies," March 8–9, 2005, hosted by Rice University <http://www.educause.edu/NLII052>. Recordings of the presentation and the accompanying slide presentation can be accessed at <http://www.educause.edu/NLII052/Program/5679?PRODUCT_CODE=NLII052/GS05>.
2. For more information about blogging in higher education, see Stephen Downes, "Educational Blogging," *EDUCAUSE Review*, vol. 39, no. 5 (September/October 2004): 14–26, <http://www.educause.edu/er/erm04/erm0450.asp>.
3. For more information about clickers, see "7 Things You Should Know about Clickers," EDUCAUSE Learning Initiative, May 2005, <http://www.educause.edu/LibraryDetailPage/666?ID=ELI7002>.
4. For more information about e-portfolios, see the EDUCAUSE Learning Initiative Web page: <http://www.educause.edu/E%2DPortfolios/5524>.
5. For more information about podcasting, see "7 Things You Should Know about Podcasting," EDUCAUSE Learning Initiative, June 2005, <http://www.educause.edu/LibraryDetailPage/666?ID=ELI7003>.
6. For more information about wikis, see Brian Lamb, "Wide Open Spaces: Wikis, Ready or Not," *EDUCAUSE Review*, vol. 39, no. 5 (September/October 2004): 36–48, <http://www.educause.edu/er/erm04/erm0452.asp>.