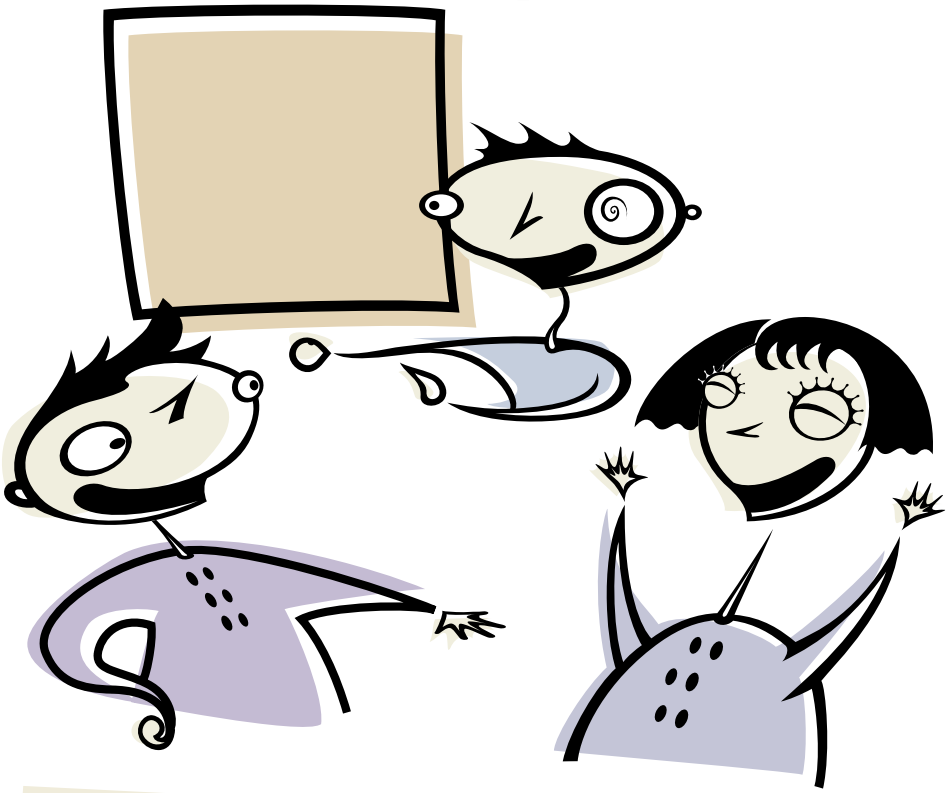
Interactive Whole-Class Display Systems



In previous eras, classrooms were self-contained. Teachers taught and students learned in relative isolation. Technology potentially alters that equation. Our new column, The Connected Classroom, explores ways in which technology encourages connections across the curriculum and with the world. We'll explore these topics, including uses of the Internet, digital cameras, handheld technologies, scientific probes and sensors, and novel technologies just emerging.

By Joe Garofalo, Glen Bull, Randy Bell, and Stephanie van Hover

Subject: "Last mile" connections

Grades: K–12 (Ages 5–18)

Technology: Presentation and projectors

In several recent studies and surveys, both beginning and experienced teachers ranked access to a projector as one of the actions most likely to facilitate more effective use of technology in their classrooms. Advances in display technologies now make this increasingly feasible. For example, digital light processing (DLP) technology is one of several recent technological advances resulting in smaller, brighter, and less expensive display systems.

The Technology Foundation

Many of the newer projection systems are bright enough to be visible in a lighted classroom. During the past five years, the cost of usable projection systems have decreased to less than $1,000, making them affordable for schools.

They come at a timely moment. During the past decade the United States has made an unprecedented investment in the technological infrastructure of its schools. In 1997, the Federal Communications Commission adopted rules that require telecommunications carriers to pay a percentage of revenues for long-distance phone calls into a Universal Service Fund.

This fee, set at approximately 9% of the cost of long-distance phone calls, generates billions of dollars each year. It is used to support Internet access for schools and libraries. As a result of this support and strong commitments by state and local school systems, the majority of U.S. classrooms now have Internet connections. However, the potential of these connections to facilitate learning in schools has not yet been realized.

Instructional Potential

The new generation of inexpensive projection systems offers one means of realizing a direct return on the

prior investment in the Internet. A projection system linked to the Internet through a computer can place the resources of the Internet at the disposal of a class and make local resources more accessible. This could be a valid rationale for advocating for use of universal service funds to make the last mile connection in schools.

In several studies we recently conducted, teachers used projectors to facilitate student engagement and inquiry. Classes projected student-generated data, text, images, graphs, and simulations for interactive whole-class analyses and discussions.

Eventually all students will have portable wireless learning devices. Our pilot studies in classrooms in which every student has such a device indicate that a projector becomes even more crucial under these conditions. When each student has an individual display, a projection display provides a common focus that brings the class together for whole-class discussions. In short, projection systems are an essential piece of the classroom technology puzzle.

Presentation Methodology

There is little research to indicate how projection systems might be used most effectively to support student learning and inquiry. Like all technologies, projection systems are susceptible to misuse. Edward Tufte, professor emeritus of computer science, statistics, and graphic design at Yale, argues that use of projection systems for presentation of electronic slide shows can adversely affect children's cognition. He noted in a September 2003 *Wired* magazine article that guidelines for students' slide show projects in elementary schools "typically consist of 10 to 20 words and a piece of clip art on each slide in a presentation of three to six slides—a total of perhaps 80 words (15 seconds of silent reading) for a week of work. Students would be better off if the schools simply closed down on those days."

Tufte's point is not that computer presentations should be eliminated, but that presentation methodologies are important. Tufte presented testimony on this issue in NASA hearings held after the crash of the space shuttle Columbia. The slide shown in Figure 1 was presented to NASA managers to brief them on potential damage to the Columbia after a piece of foam struck the wing of the shuttle during lift-off. NASA managers then needed to make a decision as to whether it was safe for the shuttle to land. They assumed there was no damage after being briefed on test results.

The NASA managers decided it was safe for the shuttle to land, but the wings disintegrated during reentry. The crucial bit of information—that the piece of foam that hit the wing during launch was hundreds of times larger than any tested—is buried in a subpoint at the bottom of the slide. The Columbia Accident Investigation Board at NASA concluded that the format of presentation of this key information contributed to the ultimate shuttle disaster, noting in its final report that, "It is easy to understand how a senior manager might read this PowerPoint slide and not realize that it addresses a life-threatening situation."

Presentation methodologies in other settings may not be life threatening, but they can contribute to loss of productivity and reduce effectiveness. It is important to prepare students in effective use of the technologies that are ubiquitous in the workplace. Teachers who model effective use also contribute to enhanced learning in schools.

Effective use of projection systems should actively involve students, going beyond static slide presentations. A wireless keyboard and mouse are an important adjunct for support of such interactive use by students. These systems, available for less than $100, allow the interactive control to be passed from student to student during class discussions. Illustrations of dynamic uses in core content areas are provided below.

The Mathematics Classroom

Dynamic visualization programs such as The Geometer's Sketchpad make it possible to teach mathematics in an interactive fashion. For example, mathematics students learn that the sine of an angle is the ratio of the side opposite the angle and hypothenuse of a right triangle. Later they graph sine functions, but many students cannot connect the ratio definition of sine to a graph of a sine wave.

A Sketchpad animation allows students to manipulate the angle at A and observe the corresponding change in associated variables. Such actions help students develop understanding of the relationship between these sine representations. A dynamic display facilitates whole-class analysis and discussion of these relationships.

We provided a projector to a middle school mathematics teacher to explore ways it might affect his teaching. Students sought out interactive algebra Web sites, such as The Math Forum and Explore Math for presentation and class discussion. (***Editor's note:*** For these and other URLs, see the Resources section on p. 31.) The teacher found that students became more sophisticated at identifying effective learning materials. They also developed more effective communication skills as they incorporated these materials in classroom presentations.

The teacher used an e-learning tool, Blackboard, to communicate

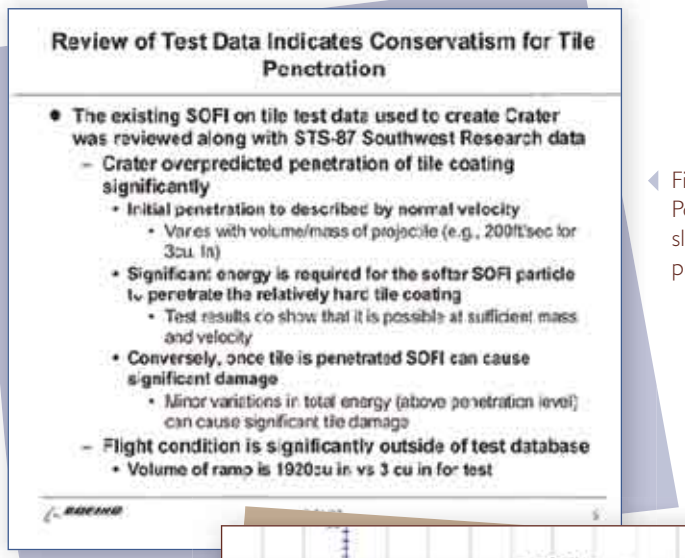


Figure 1. PowerPoint slide used to present shuttle data.

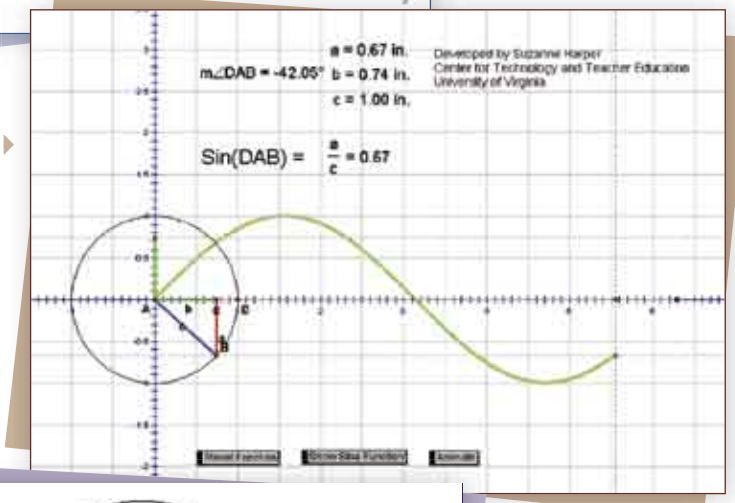


Figure 2. Animation tool for dynamic display of a sine function in The Geometer's Sketchpad.

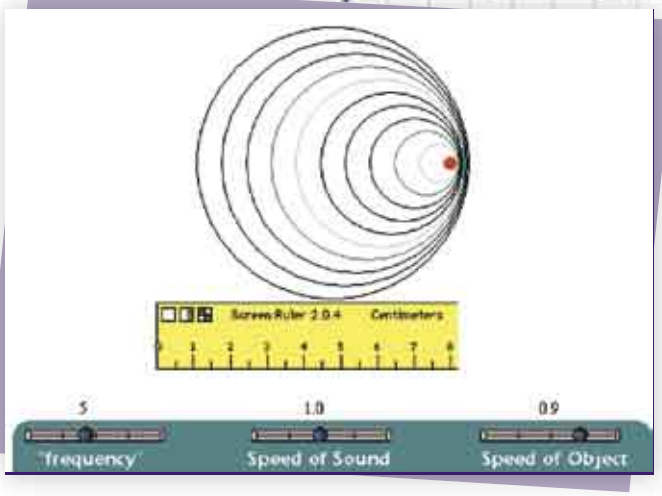


Figure 3. Computer simulation of the Doppler effect.

with his students outside of class. He posted problems for students to accesss at home or at community sites such as the library. Students posted their solutions to problems and also posed questions. The students used the projector to display and discuss their solutions in class the following day.

The Science Classroom

Much of the subject matter of science is abstract and can only be taught in a concrete manner through specialized visualization techniques. Images projected for students in a science classroom can be especially effective at illuminating concepts that might be intellectually abstract. Why simply describe the action of sound waves emanating from a moving object, when students can observe the process as it occurs? The Doppler effect is a familiar but abstract science concept taught in secondary physical science classes. It describes the change in frequency that occurs when a wave source moves relative to the observer. The shift in the wail of a train whistle as it passes a road crossing is a classic example. This phenomenon is part of students' everyday experiences, but its explanation is neither easily visualized nor commonly understood. Traditional explanations in science classrooms have been limited to static images that fail to convey the complexity of the phenomenon.

Simulations such as those at ExploreScience.com make waves visible, allowing students to directly observe the behavior of sound waves emanating from a moving object. More importantly, the simulation permits teachers and students to manipulate factors such as the speed of the object, the speed of sound, and the frequency of the sound emitted by the object.

Thoughtful use of the simulation by a capable teacher with a single computer and projector permits the entire class to engage in an inquiry lesson on the Doppler effect through careful orchestration of key questions, exploring student ideas, and giving individual students opportunities to draw conclusions from what they observe on screen.

In a dissertation conducted at the University of Virginia, Karen Elizabeth Irving found preservice teachers who had access to whole-class display systems in their classrooms were more likely to use technology as a vehicle for increasing inquiry and student engagement in their science instruction, in comparison with those who did not. These findings are supported by Rebecca Lee McNall's investigation into beginning science teachers' use

of educational technology during their induction year, as reported in her dissertation.

The Humanities Classroom

In their dissertations, Adam M. Friedman and Kathleen Owings Swan found that digital resources promote student engagement and inquiry in the social studies classroom when used effectively. Social studies teachers access a plethora of maps, graphs, and digital primary sources over the Internet. Use of these materials, projected to the whole class, offers teachers the opportunity to engage students in consideration of multiple perspectives.

For example, a geography teacher used a projector to display photographs representing different regions of the United States. Students wrote down what they saw in each picture and then broke into small groups to collaboratively identify the region portrayed in each photograph. The teacher projected the pictures a second time and asked the groups to explain their decisions.

In language arts classes, teachers engage students in interactive discussions of images and text. For example, students analyzed writing samples using a rubric with three components (composing, written expression, mechanics) and generated characteristics of powerful writing. Following student analyses, the writing samples, with superimposed color-coded highlights (different colors for different aspects) and pop-up comments, were projected to show students how these samples were rated by writing experts. Students then compared their assessment to those of the experts. This could not readily be done without a projector.

The Importance of Preparation

Many teachers are not prepared to use this technology effectively to enhance instruction even when they do have access. Swan found that social studies teachers with unlimited access to projection systems in their classrooms used them in very different ways, related to their background and education.

The models most teachers currently observe during their preparation involve use of projection systems for static, didactic presentations. Models and materials are needed to prepare teachers for a shift in instruction. Current research indicates that technological access in the absence of appropriate pedagogical content knowledge does little good and may be harmful. We are in the process of designing a series of research studies to identify best classroom practices for use of interactive display systems in specific content areas.

Conclusions

Computer projectors have fallen in price dramatically. As a result, schools are buying projectors in increasing numbers. Schools are realizing that adding a projector to the classroom is a more effective strategy than simply acquiring a second computer for the classroom.

Recent research indicates that provision of a projection system can remove barriers to effective use of technology to enhance learning. A language arts teacher who received a projector this year commented on the effect on her teaching, "When I previously tried to show Web sites on my computer, it was ineffective to have 17 kids huddled around my computer monitor."

Internet use is increasingly taking place outside schools, outside the direction of teachers. A projector can allow teachers and students to bridge this gap to use this resource in class. However, teachers must be prepared to use this resource in effective ways.

Resources

The Doppler Effect Simulation: http://www.explorelearning.com/index.cfm?method=cResource.dspDetail&ResourceID=18

Explore Math: http://www.exploremath.com

Exploring Trigonometric Functions: http://www.teacherlink.org/content/math/activities/skpv4-trig/

The Math Forum: http://mathforum.org

Dissertations

Friedman, A. M. (2004). *Digital primary source use in world history and world geo-graphy.* Unpublished doctoral dissertation, University of Virginia.

Irving, K. E.(2003). Preservice science teachers' use of educational technology during student teaching (Doctoral dissertation, University of Virginia, 2003). *Dissertation Abstracts International, 64,* 2436. Available: http://wwwlib.umi.com/dissertations/preview/3097272/.

McNall, R. L. (2004). *Beginning secondary science teachers' instructional use of educational technology during the induction year* (Doctoral dissertation, University of Virginia, 2004). Available: http://wwwlib.umi.com/dissertations/preview/3108794/.

Swan, K. O. (2004). *Examining the use of technology in supporting historical thinking practices in three American History classrooms.* Unpublished doctoral dissertation, University of Virginia.

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