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Teaching Enhanced by Technology:

One novice teacher's experience with integrating technology into science teaching

by Jackie McDonnough and Ryan Templeton

Technological advances have ushered in myriad changes for our economic, social, and education institutions. The changes brought about in education have the potential to inextricably alter instruction within the next generation. These changes, though far-reaching, cannot be fully realized unless the gatekeeper of education, the classroom teacher, is willing to embrace these transformations. Teachers in essence have to transition from traditional instructional delivery modes to modes that include instructional technology. Use of textbooks and teacher lectures, the primary modes of content delivery, is no longer able to serve the information needs of students, especially in science education. Thus, teachers of science have to make a transition towards greater use of instructional technology to enhance students' access to current, relevant instructional resources.

The field of science is continuously changing and instructional technology can be used as a valuable tool in assisting teachers to stay abreast of new findings. Teachers have to seek out unique ways to keep content information current while maintaining academic rigor and sound science education pedagogy. The need is especially urgent in honors and advanced placement high school science classrooms. This population of students is generally technologically savvy in addition to being academically advanced. Thus, technology use for this population has to be woven seamlessly and meaningfully into instruction.

This paper will document one novice science teacher's use of technology for instructional and classroom management. He teaches both

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honors and Advanced Placement Biology at a specialty science and mathematics high school. Through the use of PowerPoint, video streaming, a self-developed technology nerve center and a class website, he has been able to increase students' access to current content, high quality graphics, and class materials.

Current Research

It is important for teachers to integrate technology into their classrooms because of its ability to provide instruction that accommodates various types of learners and to increase student academic achievement. Students may view pictures and animations, listen to sounds, and read and answer questions through the use of computers (Ostiguy & Haffer, 2001; Loegering & Edge, 2001-2002). Several textbook companies have CDs or Internet sites available for students to access, and they often include graphs, tables, pictures, and practice quizzes (King & Hildreth, 2001). The World Wide Web opens new realms to students and teachers by offering access to current scientific data, from databases, satellites, museums, online libraries, research institutions, and other science classrooms (Bodzin, 1997). Therefore, technology allows teachers to vary instructional methods through the use of multiple resources.

Increased student achievement is by far the most significant outcome of instructional technology use. Various studies of technology use in secondary and college science classrooms have confirmed this benefit (Siegle & Foster, 2001; Loegering & Edge, 2001-2002; Mantei, 2000).

Despite the obvious benefits, some teachers may need more motivation to make the drastic changes that use of instructional technology entails. The words of Paul Hurd, the eminent science educator, make the case that "those who see a reinvented curriculum recognize that science and technology have become the driving force in our nation's quest for a better society", and that we must "recognize that the nation is moving from an industrial age to an information age." Educators do not want to be left behind in the move that has already begun. Thus, teachers need to find ways to begin the process of change necessary to integrate technology into their instruction. Teaching Enhanced by Technology (TET) offers the novice educational technology user an avenue through which change could occur.

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Teachers with little or no experience with using instructional technology will be more likely to make the transition towards fully integrating technology use into their instruction if they are allowed to make changes in small, incremental steps. The logical place to start is to focus on the 50% of class time that is devoted to content delivery. If guided by the following question: "How do I make instruction more engaging, current, and applicable?", they can then begin to seek out instructional technology components that can enhance their teaching.

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There are some basic guidelines that should be followed by these novice technology users to incorporate technology into their instruction. According to work done by Flick and Bell (2002) with pre-service science education teachers, the objective should be to integrate technology into science instruction in an authentic context that harnesses the unique features of the technology without sacrificing sound pedagogy. Flick and Bell suggested that teacher educators keep the following in mind as they design science methods instruction:

1) technology should be introduced in the context of science content;
2) technology should address worthwhile science with appropriate pedagogy;
3) technology instruction in science should take advantage of the unique features of technology;
4) technology should make scientific views more assessable; and
5) technology instruction should develop students' understanding of the relationship between technology and science.

Although these guidelines were developed for using technology in the preparation of science teachers, I contend that they are applicable to technology in the K-12 science classroom.

Teaching Enhanced by Technology supports sound pedagogical practices advocated by Flick and Bell while keeping the needs of the novice teacher foremost. The path to success of the novice technology user when incorporating technology into science instruction necessitates developing a plan that allows for acquisition of new skills in incremental steps. Teachers should begin by reflecting on their instructional needs and choosing a technology tool that would satisfy that need. Once a tool has been selected, the teacher will need to acquaint herself with the tool through professional development, peer or self-instruction. After a period of practice, integration into the classroom should begin on a limited basis. During this transitional period, the teacher should create opportunities to reflect on the success of the tool. Reflection, to be of value, should involve both an individual and a peer component. The individual component can take the form of reflective journaling focused on teaching practices and modifications based on those experiences. The discussion with peers of issues encountered while using technology may provide valuable insights and supports. The experience of one novice will now be explored.

Mr. T's Class

The participant is a novice science teacher at a specialty science and mathematics high school. He began his third year of teaching the fall of 2002. His began using technology during his second year of teaching after observing more experienced colleagues' use of presentation software and grade management tools. He now uses technology for instructional and classroom management in both honors

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and Advanced Placement Biology. Through the use of PowerPoint, video streaming, a self-developed technology nerve center and a class website (URL at end of article), he has been able to increase students' access to current content, high quality graphics, and class materials.

PowerPoint presentations are used on a regular basis to present lecture notes, announcements, and quizzes. Graphics and streaming video are downloaded from the textbook publisher and integrated into PowerPoint presentations. Notes for the honors classes are available for downloading after the class lecture. Advanced Placement students have access to class PowerPoint presentations after the daily lectures. PowerPoint presentations are also used for the administration of daily quizzes based on assigned readings. Daily quizzes, which do not need to be photocopied before class, are displayed using PowerPoint. The questions are presented one per slide and the final slide contains all five questions. These questions are short-answer, and answers are often one to two sentences. For example, a question might be phrased as "How is the energy in adenosine triphosphate released?", or "What is the sugar produced from photosynthesis?"

Streaming video is a new media format available form the Internet. Video clips on most science topics at all grade levels can be accessed on the web (URL at end of article). School systems or individuals contract with the company, United Streaming Video, to have unlimited assess to their materials. The material can be downloaded and used in segments by inserting them into PowerPoint presentations or as stand alone video clips. This media can convey in a unique way specific content that cannot be shown in still pictures. An added advantage to time-strapped teachers is that the technology provides easy access to high quality video segments without having to reserve a video, VCR, and monitor ahead of time from the school's media center.

For example, in a typical lesson concerning cellular division, students may not be able to visualize the significance of the mitotic events if shown only four or five "snapshots" depicting prophase, metaphase, anaphase and telophase. A short video can show these stages as they truly are: critical actions within a dynamic process that is not easily broken into individual points. Students can see through motion that the steps of mitosis are not simply isolated stopping points, but in fact sequential phases that mesh together and accomplish a common purpose.

An LCD projector is used to project computer, VHS, and DVD images. The larger screen allows for more dramatic visual presentations. Sound quality is enhanced through the use of purchased speakers. This setup is also used to present video segments to introduce topics, stimulate discussions, and summarize topics.

Mr. T's use of the Internet is multifaceted. He accesses the web to show animations

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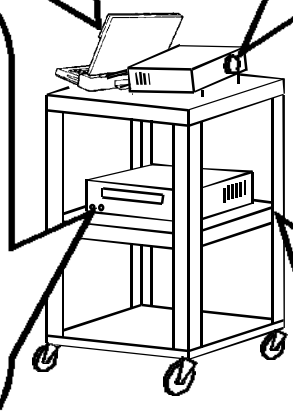
of scientific processes from the textbook web-site. He also copies and pastes test questions from the textbook site for use in class tests and quizzes. Virtual laboratory experiences are made available for AP classes.

To make the use of these different forms of technology convenient and trouble free, Mr. T has assembled a cart of equipment he has dubbed his "Technology Nerve Center" (TNC). The TNC consists of a utility cart with a desktop or laptop computer, an LCD data projector, and a VCR (see Figure 1). The TNC allows the instructor to seamlessly navigate among the variety of technology tools needed during a lesson.

Teaching with a Technology Resource Cart (Figure 1)

Computer Desktop/Laptop – ($699-$1000)
- Fits onto cart or nearby desk.
- Can fit a desktop tower on lower shelf if necessary.
- Recommend 1 GHz or higher processor with 256 MB RAM, CD-ROM/DVD drive.
- Allows access to Internet websites using school network.
- PC or Mac compatible.
- Use with Computer Speakers ($30)

LCD Data Projector – ($1400-$2000)
- Projects everything students need to see:
  - Notes
  - Video (VHS, CD-ROM, DVD)
  - Internet Website
- Speakers connect for flexible sound control
- Remote allows for quick transitions
- Choose appropriate lumen intensity



VCR – ($129)
- Primary use as a VHS player
- Play video series, news segments from TV, movies, or classroom videos made during presentations.
- Sound may be routed from VCR using an adapter available from electronics store.
- Input/Output may be reversed to tape a presentation.
- No more TV! Big screen feel and very mobile.

Media Cart – ($50)
- Whatever you use, allow space for it to fit on the cart.
- Mobile, convenient, accessible.
- Have it equipped with a power strip, only plug one cord in when traveling.
- Components may be affixed with plates and screws for security.
- Computer and projector usually equipped with safety lock port. Cables can then be looped around cart supports or desk.

Lighting – Dark rooms put students to sleep and make note-taking hard. Position your projector as close to the screen as possible so that it projects the maximum amount of light. Remove fluorescent bulbs directly over the screen if necessary.

File Transfer – Saving files on floppy may be difficult. Consider using a rewritable CD-ROM, Zip drive or other large capacity drive. Alternatively, files may be stored on the network and retrieved when needed. Save files to the hard drive for faster performance. And no matter what, back-up often!

Substitutes – You may consider training a student in each class on the use of the VCR with the projector, in case you ever wish to leave a video with a substitute.

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Students can access the class website to download handouts, laboratory assignments, pre-tests overviews and links to pertinent content information. They also have a direct link to their instructor's email to ask questions as necessary. Parents are encouraged to access the website to keep abreast of students' assignments or to contact the instructor. The site is linked to a grade level Research website. This website contains information specific to the yearly-required research assignment.

A typical day in the classroom would begin with students entering the classroom, where a large screen displays the words "Quiz 4-3". Students would take their seats and begin to review their notes before the tardy bell rings. Once class is underway, the instructor would use an infrared mouse or keypad to advance the slides to the quiz questions, pausing two minutes on each slide. During this time, the instructor may take role or monitor students as they take their quiz. At the end, a summary slide would display all questions and students would review their answers for correctness. The instructor would shutter the projector and collect the quizzes.

The instructor may then engage the students in a few minutes of discussion about the lesson plan for that day. This might be followed by ten or fifteen minutes of note-taking from instruction using the projector and a PowerPoint presentation. Students would be able to see vivid color slides that show more than they tell. Students are expected to make notes on what the projector displays and what the teacher says. During this period of instruction, a streaming video clip could be shown to reinforce the topic.

A laboratory experience would be prefaced by a pre-lab discussion, which could include digital pictures of what the students are about to see, again projected by computer. For example, if students are working with Drosophila flies, the instructor could show details that would aid the students in identifying males and females, as well as mutation phenotypes. In this way, the instructor can interact with all students at once, rather than individually at every microscope. The size and detail of the digital pictures enhance question answering and the files could be displayed later on a website for student review. Depending on the preferences of the teacher, class notes and lab handouts could be posted on a class website.

Mr. T. has increased his use of instructional technology dramatically since his first year of teaching but this change came about in small steps. He began by using grade management software to decrease the amount of time spent on grading. He then learned to use presentation software. A need by his students for greater access to science project research materials motivated him to learn web site authoring. Over time a synergistic relationship developed between his desire to improve instruction, students' needs, and his need for greater skills with instructional technology.

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Discussion

The use of technology by this instructor has had many benefits to both the teacher and the students. The teacher now has tools to deliver engaging content more efficiently. Integration of presentation software with lecture and laboratory exercises streamlines the content delivery and maximizes instructional time. Using the class web site, students can access reading lists, previous class notes, and tests. These materials convey a sense of organization on the part of the teacher and have the added advantage of allowing students to have greater responsibility for their learning. Students are exposed to high quality, current content information presented in a manner that increases their engagement. The class web site also allows parents to get up-to-date information about class assignments and instructional practices.

The typical advanced placement or honors science teacher is a person well versed in the content and in general has some educational technology experience. Students in these classes experience success to a greater degree than do students in lower-level academic classes. The conflict occurs when these teachers are asked to modify proven teaching methodology in an effort to integrate educational technology into their teaching repertoire. Using the steps outlined by TET, teachers can transition to instruction using a variety of educational technologies without totally restructuring their curricula.

Article Resource Links

Class website: http://chaucer.chesterfield.k12.va.us/~rtemplet/index.html

Science video clips: http://www.unitedstreaming.com

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