Chapter 28
Science for Everyone:
Visions for Near-Future Educational Technology

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ABSTRACT

Recent and emerging technologies offer many opportunities for exploration and learning. These technologies allow learners (of any age) to work with real data, use authentic scientific instruments, explore immersive simulations and act as scientists. The capabilities soon to be available raise questions about the role of schools and do rely on directed learning traditionally supplied by teachers. The prevalence of new tools and data streams can transform society, not just kids, into a culture of learning.

FRAMEWORK

Predicting the future of educational technology is difficult. New ideas, products and capabilities spring into existence and are developed within months, making it nearly impossible to predict the exciting new opportunities even a few years from now. But we can say that technology will be increasingly incorporated in most aspects of formal, informal, and casual education, and that it will build upon today's capabilities. In this review I discuss some current and emerging technologies and suggest how they might be used to increase learning in science, technology, engineering, mathematics, and geography (STEM-G). I don't describe well-entrenched tools, nor administrative or teacher management applications, and am not limited to classroom uses. These are personal choices of tools with high opportunities for engaging learning.

The foundation of most educational technologies is the World Wide Web and similar networks (e.g., wireless cell phone nets) that are already widely available in the Western World and many parts of Asia (though issues of financial access still loom everywhere). These networks are becoming more pervasive (even invasive), ever faster, and ultimately everyone in developed nations will be connected. The educational value of evolving networks is that learners will be able to connect to almost every conceivable kind of learning opportunity, anytime,

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from almost any place. Once online there are already a great variety of interactive learning activities, including control of real and simulated scientific instruments, expeditions to tag along with, courses to take, simulations and games to play, and literally billions of content-rich web pages to peruse. And increasingly these activities are not done alone, but rather within communities. *Second Life, Halo* and a growing number of other synthetic worlds bring teams together to talk, solve problems, share experiences, and collaborate. This is immersive, shared learning that young people seem to do naturally.

The value of educational technology is often unvalidated through formal assessments, yet is widely considered important because it makes learning more lively and more participatory, plus develops skill in using technology, itself a learning goal. If a learner becomes engaged in the tasks, it is assumed that there is a higher likelihood that the experience will be productive. The uses of technology described here are generally ones that require involvement and interactions—observing, collecting, displaying, and interpreting data; making decisions that have learning consequences; and using instruments normally beyond typical educational experiences. And the learning opportunities typically focus on important problems worthy of a learner's time and effort. Trivial labs and make-work exercises with non-real data are intrinsically boring, but activities based on real data and socially significant STEM-G issues capture attention. The Internet and online tech tools bring the world live into our learning environments.

REAL TIME DATA

Many organizations place near real-time data online, providing opportunities for classes and individuals to experience authentic data analysis, often using professional tools. One extraordinarily successful example is the discovery of comets in the daily solar images obtained by the SOHO spacecraft and placed online. As of July, 2008 (http://home.earthlink.net/~tonyhoffman/SOHOleaderboard.htm), 1500 comets have been discovered by 67 amateur astronomers from 17 countries. Most of these comets would not have been found without the amateurs because professional astronomers do not have the time to search the daily flood of data. Other examples of discoveries from online astronomy data are numerous, including the discovery of asteroids, variable stars, and supernovae. School kids have even discovered proto-planetary objects out beyond Pluto. With the imminent arrival of massive surveys that map the entire sky every three nights, there will be more near real-time astronomical data online than all the astronomers in the world can review. With the creation of appropriate tools, there can be an explosion of science discoveries and explorations by adults and youth everywhere. Science is becoming an activity for everyone.

The GLOBE Project (http://www.globe.gov/fsl/html/aboutglobe.cgi?intro&lang=en&nav=1) is another successful example of youth making and analyzing observations, this time of their local environments, which contribute to global scientific understanding. More than 40,000 teachers have been trained to use GLOBE in their classrooms, and 19 million measurements have been contributed by more than one million students in 110 countries. GLOBE must be one of the largest international data collection/education programs ever.

Other types of near real-time data allow students to share the excitement of current geophysical activity. For example, near real-time seismic data are displayed on interactive maps by the U.S. Geologic Survey (http://earthquake.usgs.gov/eqcenter/) and the Incorporated Research Institutions for Seismology (http://www.iris.edu/seismon/). With creation of easily mastered online tools, learners could determine where earthquakes are centered, and estimate magnitudes and potential damage. Follow-up on CNN and