The Cutting Edge: Promising Technologies and Strategies for Online Science Education

Are these the shadows of things that Will be, or are they shadows of things that May be, only?

– Ebenezer Scrooge, A Christmas Carol

The evolution of online education will continue to be coupled to and constrained by innovations in communication and information technologies (CIT). Only a few years ago, Web-based courses were characterized by slow data transmission, at 56 kbps with dial-up lines that dramatically limited the styles of communication and the amount of multimedia that could be incorporated directly through the Internet to support learning. As a result, course development was regularly compromised by technical limitations. For online education, the ideal threshold in data transmission speed is that point at which an author’s course vision and creativity is unrestricted by the instructional hardware and software permitting the effortless incorporation of interactivity styles and multimedia. This ideal will be met at different times by particular course authors, institutions, and even between disciplines (e.g., English versus science).
A related constraint on innovation in online science learning is the cost of technology for both the student and the institution. It is reasonable to assume that the cost of technology to support online learning will decrease in the vein of Moore’s “Law” where transistor and integrated circuit improvements have consistently lowered computer costs and increased their capabilities. However, online science instructional designers still need to be cognizant of and avoid overshooting the average learner’s ability to pay for elevated technology requirements to support core-learning activities such as practical work. In many cases, it will be incumbent on institutions to either support the technology requirements of online-facilitated practical work themselves or collaborate with other institutions as in the case of remote experiment consortia. What is more, online science learning practice will recurrently take advantage of popular technologies that emerge initially for personal use where pedagogical application is sensible and cost is low as it has recently for podcasting or SciVee at http://www.scivee.tv/, a YouTube-like entity for scientists. Using “everyday” technology will enhance online science learning without adding extraordinary cost.

Distance education programs in the United States now routinely assume in their course design that students have digital subscriber lines (DSL) capable of smoother multimedia transmission and telephony. What is more, mobile communications are rapidly evolving and will also be able to provide Internet service downloads of media-rich information at high-speeds with concurrent advances in cellular communications such as third generation digital technology (3G) or the evolving “4G” (Lawton, 2005) and the rapid wireless broadband structure of evolution data only/evolution data optimized (EVDO) “Revision B” (Williams, 2005). Additionally, there is a trend towards the merging of today’s TV’s with Internet features into a common digital network (Walczak et al., 2006) such that there may be a corresponding common hardware for computing and learning/entertainment media. This has the potential of markedly enhancing the visualization capabilities of home learning systems.

Beyond raw increases in transmission speed, many emerging CIT innovations promise to have a substantial impact on the character of online-based science education. For example, the Learning Federation, a consortium of higher education institutions, businesses, government agencies, and foundations (http://www.learningfederation.org/index.html), has been endeavoring to set forth a roadmap for future research and development efforts in educational software in NSF’s Science, Technology, Engineering and Math Education (STEM) categories. The five critical areas identified by the Learning Federation are: (1) instructional design for learning games and simulations, (2) intelligent question and answer systems to individualize learning, (3) learner modeling and assessment, (4) building virtual learning environments, and (5) integration tools for building and maintaining advanced learning systems (van Dam, 2005). These stated goals provide an indication of the future of online science and reflect many of the promising technologies and strategies discussed next. In this chapter, we examine enhancements and/or innovations in learning systems that can affect the quality and character of online science education including virtual classrooms and Web-broadcasting studios, remote laboratories, mobile science learning, visualization, virtual reality, advanced educational games, haptic design, virtual instructors, and virtual museums.
The Adaptation of a Residential Course to Web-Based Environment for Increasing Productivity