Chapter VII

Online Science: Contemporary Approaches to Practical Work

Philosophers say a great deal about what is absolutely necessary for science, and it is always, so far as one can see, rather naive, and probably wrong.

– Richard Feynman (1918-1988)

Distance learning modalities in the natural sciences range from simple notes and discussion online (e.g., PowerPoint and asynchronous discussion threads), to remarkably sophisticated multimedia applications that enable students to explore complex systems such as the human body (e.g., The Visible Human Project, National Library of Medicine). In medical and engineering fields, the vanguard for testing the feasibility of learning technologies in online science, students both with time constraints or those far from educational institutions all benefit from sharing resources such as remote laboratories and virtual field trips, resources that are becoming increasingly sophisticated.

Even so, the vast majority of Web-based science courses still fail to take full advantage of these interactive and push-pull technologies, relying on the learner’s desire to dig further (pull) within the course resources, rather than automatically delivering content at key points (push). In many cases, components/modules of courses are non-interactive and often resemble...
nothing more than lectures adapted to the basic learning tools of learning management systems (LMS). In some cases, courses are technology-centered and basic pedagogical concepts (e.g., scaffolding) are not used. Even the modest incorporation of emerging innovations in information and communication technologies (ICT) can provide affordances to the student including: (1) promoting cognitive development, (2) enabling students to relate science to real-world experiences, (3) increasing students’ self-management, and (4) facilitating data collection and data interpretation (Webb, 2005). Despite the affordance of ICT, a general and strategic national vision, set of best practices, and coordinated effort for online science instruction is noticeably lacking throughout K-16.

Among the key forms of contemporary online instructional design and practical work approaches reviewed here are simulations, remote laboratories, and virtual field trips. In addition, we review the idea of learning objects, elaborate on the use of multimedia in online science instruction and describe how home laboratories, educational games, puzzles, digital libraries, and blended sciences courses fit into emerging online science pedagogical practice. The discussion in this chapter is interwoven with examples that are a prelude to the more exhaustive treatment of mathematics and natural science examples reviewed in Chapters X-XII.

**Learning Objects**

Online learning environments and the object-oriented paradigm of computer programming have given rise to the idea of the learning object (LO) which Wiley (2000) defines as “any entity, digital or non-digital, which can be used, re-used or referenced during technology supported learning” (p. 4). Subsequently, the IEEE standard has been developed and defined so that the LO is now considered as any digital entity that can be used and re-used in a context of technological learning (IEEE, 2002). Thus, reusability has become part of the LO standard. In an applied sense, instructors who are designing online materials for a science course that can be reused in the future following reusability standards are building a LO. Learning objects range from very simple entities, for instance a digital photograph or e-mail, to complex multimedia entities such as streaming video with sound or an interactive 3-D model of human anatomy. Hence, for online science, learning objects are the stuff courses are made of. Haughey and Muirhead (2005) consider the chief importance for learning objects to be assisting in the introduction of new topics and skills, and providing reinforcement to existing skills. As well, they extend learning by providing new means for presenting curricular material and illustrate concepts less easily explained through traditional teaching methods. Finally, learning objects support new types of learning opportunities not available in a classroom environment and provide enrichment activities for gifted and highly motivated students (Haughey & Muirhead, 2005).
A Mathematical Problem-Solving Approach to Identify and Explore Instructional Routes Based On the Use of Computational Tools


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