Learning Science through Collaborative Visualization over the Internet

Roy D. Pea

Abstract: Ten years ago, we launched the Learning through Collaborative Visualization, or CoVis Project. "Collaborative visualization" refers to development of scientific knowledge that is mediated by scientific visualization tools in a collaborative learning context. Funded by the National Science Foundation as an advanced networking testbed, our partnership of Northwestern University, Bellcore, Ameritech, the Exploratorium Science Museum in San Francisco, and the University of Illinois at Urbana-Champaign's Atmospheric Sciences Department/National Center for Supercomputing Applications (NCSA) sought to design, implement and research the promises and problems of a distributed multimedia science learning environment that used broadband desktop videoconferencing and screen sharing, scientific visualization tools and distributed datasets, virtual field trips, scientist telementoring, and a Collaboratory Notebook for enabling project-based learning of science in the high school using these distributed human and technical resources. Our project vision was to establish collaborative technology learning environments, or "collaboratories" that would enable project enhanced science learning among remote project partners using advanced telecommunication networks. For example, our collaboration with NCSA scientists provided learners with access to subject-matter experts, visualization tools and vast databases in the field of atmospheric sciences. Virtual visits using wireless video over the Internet to Exploratorium exhibits helped motivate student questions about central scientific phenomena. At its peak of use, the CoVis network was in use by thousands of teachers throughout the United States. The project developments were transitioned in 1997 as a set of resources that continue to be elaborated in the LeTUS Center for Learning Technologies in Urban Schools based at Northwestern and University of Michigan, which is investigating in partnership with the Chicago and Detroit public school systems how to support urban school teachers in using project-based inquiry as their core approach to teaching earth and environmental sciences at the middle and high school level. In this chapter, after providing a pedagogical background that lays out the rationale for bringing together developments in the sciences of learning with advances in high performance computing and communications in the CoVis Project, I will highlight our design research methodologies for making the powerful features of professional scientific visualization tools usable to students and teachers in WorldWatcher.
Students submit their data through the Internet to a GLOBE data archive, which both the scientists and the students use to perform their analyses. A set of visualization tools provided on the GLOBE World Wide Web site enables students to see how their own data fit with those collected elsewhere. Emerging technologies and new ideas about teaching are being combined to reshape precollege science education in the Learning Through Collaborative Visualization (CoVis) Project (Pea, 1993a; Pea et al., 1997). Over wideband networks, middle and high school students from more than 40 schools collaborate with other students at remote locations. The Learning through Collaborative Visualization (CoVis) Project at Northwestern University, in conjunction with the Department of Atmospheric Sciences at the University of Illinois, Urbana-Champaign and other academic and industry partners, will provide high school students with the opportunity to learn atmospheric science by engaging in the practices of the atmospheric science community. In the context of engaging in student-initiated science projects, CoVis students will use a high-performance computing and communications network (wide-band ISDN) funded by NSF to gain access to atmospheric science data.