

Modeling Across the Curriculum: Scaling up Modeling using Technology

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Modeling environments, we believe, can make the most significant contribution of information technologies to improved science learning. A partnership of the Concord Consortium, Harvard and Northwestern Universities, with the help of the Josiah Quincy Upper School and the Fitchburg and Lowell Public Schools, is studying the impact of modeling on secondary science learning.

The project uses tools we call CIE models: environments that incorporate core science content that students learn through inquiry and exploration. Increased learning is expected from a curriculum focused on a few core science concepts that students learn primarily through guided exploration of CIE models. The project goal is to test this expectation in real schools as students encounter a representative set of CIE models over three years in sequential physical science, chemistry, and biology courses. The tools that are used in these courses are Dynamica (Horwitz et al, 2001), Connected Chemistry (Stieff, M & Wilensky, in press) and BioLogica™ (Horwitz & Christie, 1999), respectively.

The project uses a powerful tool, Pedagogica, developed at The Concord Consortium that provides online lessons with embedded guidance and assessment. Pedagogica controls all aspects of the learners' interactions with the software tools by changing the available options, the nature of the scaffolding, the instructions, and the assessments. Pedagogica can automatically report student progress through these lessons via the Internet, providing real-time, fine-grained, educationally significant data on student learning.

The project consists of a series of studies using as outcome measures, gains in content knowledge, modeling skills, epistemological understanding, and motivation. The first group of studies focuses on improving the instructional design through individual interviews of students and teachers. The classroom-based studies evaluate the impact of variation in at least two important pedagogical dimensions: degree of constructivism and the type and amount of scaffolding. The design involves randomly assigning the *same* science content, but different

scaffolding, to different students within a class, thereby limiting the problems of bias and self-selection that often confound in-school research. At the same time, Pedagogica will automatically document how students interact with the material and the pedagogy, and track their learning during treatment. We are also conducting a longitudinal study of three-year implementations of project materials in the Partner Schools and, during the latter years, in ten Member Schools. Cumulative gains in the content areas, transfer to other topics, modeling skills, epistemological understanding, and attitudes about science are being measured. All data are collected from Pedagogica, annual administration of a project-generated assessment, extensive interviews, and standardized tests. With this, we are addressing how this can be adapted in order to scale up to serve large numbers of students across the country.

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