Commentary

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Designing Computer science of Learning Environments

Andrey Whiteson *

Department of Computer Science,Center for Life Nano & Neuro-Science, Fondazione Istituto Italiano di Tecnologia (IIT), Roma, Italy

***Corresponding author:** Andrey Whiteson, Department of Computer Science, Center for Life Nano- & Neuro-Science, Fondazione Istituto Italiano di Tecnologia (IIT), Roma, Italy; E-mail: awhiteson1256@gmail.com

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Description

Instructional designers commonly lament that research, especially cognitive research, is too general to be used for making decisions in the design of complex instruction. On the other hand, they also complain that specific examples of effective instruction are often too idiosyncratic to provide principles or generalizations for further work. This paper describes intermediate-level generalizations that are less abstract than those typically found in cognitive psychology but more useful than descriptions of specific design decisions or innovative courses. Essentially this paper illustrates that trial and refinement, which has been shown to benefit the design of complex curricular innovations, can also yield rules of thumb and conjectures to guide future designers. The framework guiding the design of the two innovative curricula described in this paper derives from the successful design of the Computer as Learning Partner (CLP) curriculum. In the next section, this paper describes the scaffold knowledge integration framework that emerged from the CLP experience. Then the trial and refinement process for both the List Processing- Knowledge Integration Environment (LISP–KIE) project and the spatial reasoning environment are described. The last section of the paper synthesizes these experiences into an updated version of the scaffold knowledge integration framework and discusses implications of this work. The scaffold knowledge integration framework reflects a view of the learner as holding a repertoire of models for complex phenomena and working to expand, distinguish, reconcile, refine, and link these models. This repertoire of models approach stands in contrast to instruction designed to instil correct models by diagnosing weaknesses and correcting them. For example, several recently developed tutoring programs seek to model students' understanding and provide instruction that modifies specific rules others advocate "replacing" models as discussed. For example, the CLP project found that students' ideas about heat and temperature were sufficiently mired in their everyday observations that the best model to help them make sense of thermodynamics was a heat flow model. It was simply too difficult for students to link their everyday observations to molecular kinetic theory. Rather, they first needed to gain some systematic understanding of their everyday experiences. Adding the heat flow model provided a firm foundation for molecular kinetic theory while also preparing students to reason about everyday problems. Building on current ideas and developing a more sophisticated repertoire of models is a lifelong learning skill. Selecting models to build on intuitions means that curriculum developers need to respect the deliberations that characterize student sense-making activities and ensure that course activities make realistic demands on students. Since students spend far more time processing everyday experiences than they do solving abstract problems presented in science classes, over time, students are likely to return to their intuitive ideas, unless they have incorporated the models taught in science classes. The reasoning processes of students often accord respect to "evidence" that experts would ignore. Providing students with the resources to continue sense-making after they finish the course involves helping students recognize the role of new models of scientific events. Students who see themselves as expanding and refining a repertoire of models can effectively guide their own learning. Students who believe that scientific advance proceeds by fits and starts are likely to add models and distinguish among them. If the social nature of scientific knowledge construction forms a part of their experience, then students can incorporate models of social interaction into their view of the scientific enterprise and into their view of their own learning.