Digital Evidence and Scaffolds in a Model-Based Inquiry Curriculum for Middle School Science

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Abstract: The Framework for Science Education (National Research Council, 2011) and the subsequent Next Generation Science Standards feature modeling as an integral component of inquiry driven classrooms. Evaluating such models entails careful consideration of fit with evidence. In this poster we discuss student use of computer animations, simulations, blogs and emails as sources of evidence in a collaborative model-based inquiry middle school science curriculum.

In this poster we present a method of using computer animations and other digitally generated and presented material in the context of a model-based inquiry curriculum used in a middle school science classroom. Model-based inquiry entails a shift away from narrower conceptions of science as hypothesis generation and testing to a view of science as a set of practices for generating scientific explanations and theories in a setting of critical discourse (Windschitl, Thompson, & Braaten, 2008). Recent developments in national science standards reflect this view; "The focus here is on important practices, such as modeling, developing explanations, and engaging in critique and evaluation (argumentation), that have too often been underemphasized in the context of science education." (NRC, 2012, p. 3-2). Our conception of inquiry-based modeling includes the use of a rich set of evidence that students collaboratively assess in small groups and use to support or rule out competing models.

Our study was conducted with over five hundred students in more than twenty science classrooms. A typical lesson included two or more scientific models that students evaluated in light of three to six pieces of evidence. Students reflected on the quality of each piece of evidence and how it related to each model, by supporting the model, contradicting the model, or being irrelevant to the model.

We used computer-based activities to enhance four aspects of our model-based inquiry curriculum including: the generation of data with simulations, enhancing authenticity of information by placing it in a context that is familiar to students, visualizing dynamic cellular processes, and multiple formative comprehension checks. Each figure below corresponds to one of these four aspects.

In a unit on cell organelles students considered the function of mitochondria. Students collaboratively used evidence to either support or refute two competing models about the function of this organelle. One model claimed that mitochondria are responsible for movement and the other posited that mitochondria generate energy for the cell. Figure 1 shows a simulation of ATP measurements of human runners measured at different time points in a training regime spread out over a number of weeks. Without the use of digital simulations this type of evidence could not be generated by students in the classroom. Figure 2 depicts an online advertisement for a quack medicinal cure for wrinkles through mitochondrial enhancement. Students read and discussed a series of email exchanges debating the merits of this treatment and the credentials of its purveyors. The email format enhanced the authenticity of this evidence by placing it in a context that is familiar to students. Other evidence was presented through blog entries for similar purposes of augmenting authenticity.

In another lesson students assessed two complex competing models of genetic resistance to HIV. Figure 3 is a still frame from an animation that was used to scaffold student understanding of the complex role of protein receptors in cell membranes and their relation to genetically based HIV resistance in humans. Prior research on students' learning in molecular genetics has shown that animations are effective for helping students learn about dynamic processes (Marbach-Ad, Rotbain, & Stavy, 2008). In the context of models of HIV resistance the use of an animation allowed students to visualize the underlying cellular and molecular mechanisms proposed by the competing models. Expert guidance, aimed at facilitating sense making during inquiry (Quintana et al., 2004), was also embedded in the animations in the form of prompts that draw students' attention to the salient comparable features of the two models of HIV resistance. Finally, we also embedded multiple formative comprehension checks of the models and evidence. These embedded assessments allowed both students and teachers to evaluate their understanding of core ideas presented in models and evidence and return to specific parts of the evidence when concepts, processes or mechanisms were unclear.

The use of digital animations of evidence and models allowed us to present more complicated mechanisms and experimental procedures that would have otherwise been too difficult for students to follow. Other forms of evidence, such as emails, online ads and blog posts, created a more authentic and familiar context, similar to the types of evidence students may encounter outside of the classroom. Lastly, these digital artifacts afforded a wider variety of model and evidence formats that students found to be engaging.

Figure 1.

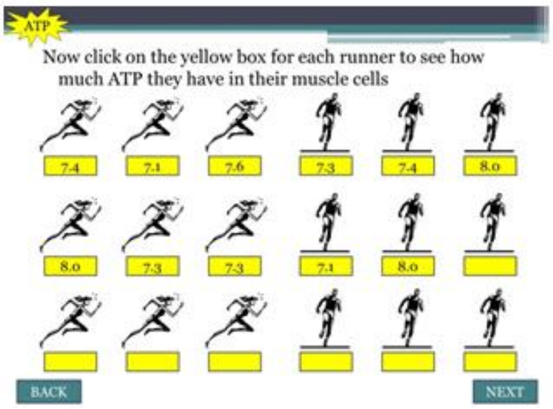


Figure 2.

Figure 3.

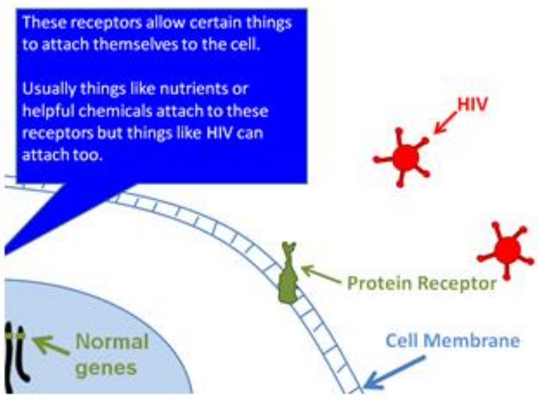
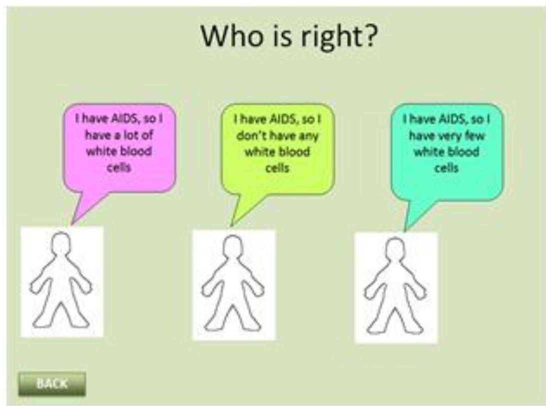


Figure 4.



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