A Breath of Fresh Air: Alternative Approaches to Learning

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Biology consists of complex systems that multiple levels of organization, such as structure and function. Interactions occur both within and between these levels (Wilensky & Resnick, 1999). Students tend to focus on the (easily seen) structures that comprise the system and miss the (mostly implicit) functional interactions. On the other hand, experts tend to focus on more on how a complex system works (Hmelo-Silver & Pfeffer, 2004). Structure-Behavior-Function (SBF) theory may provide a deep principle that is useful for thinking about complex systems (Goel & Chandrasekaran, 1989). SBF theory provides a framework that allows effective reasoning about the functional and causal roles played by structural elements in a system. by describing a system's structures, their purpose in the system (functions), and the mechanisms that enable their functions (behaviors).

Most biology textbooks present information in a linear format that causes students to focus on the structure and miss the connectedness that characterizes the system. The goal of our research program is to understand different ways in which conceptual representations such as SBF can be used to support deep learning about complex systems. We have used the SBF conceptual representation as a representational tool to design the architecture of hypermedia that will help scaffold students learning about the human respiratory system and guide them towards using the SBF model to understanding other complex systems. Using hypermedia should facilitate deeper understanding by allowing students to go back and forth between different functions and behaviors of a system without impeding the flow of the explanatory text (Jacobson & Archididou, 2000). We use the human respiratory system as an example domain to design an instructional hypermedia that foregrounds functions and behaviors. These aspects of the system are difficult to understand but critical for constructing a coherent representation of a complex system. Students begin by understanding the functions of the respiratory system. Only after students have recognized the need for a particular function and how it is accomplished (i.e. behaviors), they are introduced to structures involved in performing the function. This should allow students to focus their attention on the functional aspect of biological systems (like experts do) and increase the possibility that they will see the respiratory system as consisting of interdependent structures, behaviors, and functions. Students can move from key function questions on the main page to screens that explain the behaviors needed to accomplish these functions and from there to the screens that explain the structures that perform these behaviors. Finally they can see animated diagrams that show how the structures involved in performing a particular function work together. The poster will present the detailed architecture of the system. This alternative (function centered) approach to learning has the potential to become a breath of fresh air by helping students understand complex systems not as a set of structures (that have certain behaviors and functions associated with them), but rather as a multileveled web of understanding.

References

Goel, A., & Chandrasekaran, B. (1989). Functional Representation of Designs and Redesign Problem Solving. Paper presented at the Eleventh International Joint Conference on Artificial Intelligence (IJCAI-89), Detroit, Michigan.

Hmelo-Silver, C. E., & Pfeffer, M. G. (2004). Comparing expert and novice understanding of a complex system from the perspective of structures, behaviors, and functions. *Cognitive Science, 28,* 27-138

Jacobson, M. J., & Archodidou, A. (2000). The design of hypermedia tools for learning: Fostering conceptual change and transfer of complex scientific knowledge. Journal of the Learning Sciences, 9, 145-199.

Wilensky, U., & Resnick, M. (1999). Thinking in levels: A dynamic systems approach to making sense of the world. Journal of Science Education and Technology, 8, 3-19.

Acknowledgments

This research was funded by NSF CAREER Grant # 0133533. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of NSF.