DEMONSTRATION OF SUPPORTS FOR STUDENT REUSE AND INTEGRATION OF KNOWLEDGE THROUGH MODELING

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Abstract. The Vmodel software supports students in building knowledge through combination, reuse and modification of models. Representational and computational supports for reuse are demonstrated.

1. INTRODUCTION

A wide variety of modelling tools have been developed and deployed in pre-college classrooms (c.f. Stratford, 1997). Despite reported success in fostering student reasoning about system dynamics, existing educational modelling systems often treat each modelling task in an isolated fashion. This passes up important opportunities to allow students to use modelling as a platform to build new knowledge on old by modifying existing models, as well by integrating parts of models or entire models with each other to represent complex aggregate systems. We will demonstrate a design developed in the Vmodel project, allowing middle and high school students to create, use and reuse models or parts of models. Vmodel supports aggregation of whole parts of models into larger models. It also supports different categories of reuse for whole models or parts of them. These include simple, literal reuse (lion → lion), reuse with modification in which some information is retained and some is changed (lion → shark) and generalization of a model or model fragment to a more general idea (lion → heterotroph) which can be applied broadly.

2. REPRESENTAIONAL DESIGN

The reuse in Vmodel is enabled by careful design of the modelling ontology and representational primitives available to students. We strive to create a small, highly general suite of modelling elements which can be localized or modified as appropriate. Using the same elements to make different models can serve to make models ontologically compatible with each other, facilitating integration of one model with another. The limited suite of elements can also underscore structural and causal similarities across models, helping students recognize when models may be analogous more easily.

In Vmodel, we base the modelling ontology on Qualitative Process Theory (Forbus, 1984) which has been used to model phenomena as disparate as atmospheric dynamics and rocket combustion. The ontology contains a small suite of entities (e.g. thing, process) parameters and relations among them (e.g. increases, influences, does). Visually, the modelling ontology is divided into two different basic representational forms: boxes and rounded boxes for entities and parameters; and arrows for the relations among them. These entities take on local values (a "thing" can be a can of beans, a gazelle or the sun), the arrows do not. Visually the boxes and ovals appear with the ontological type on the bottom and a student created instance label in a text field above it. Changing entity type is easy. With a double click and some typing a cat can become a dog or heat flow can become water flow. In order for reuse to be more productive, we encourage students to reuse parts of models larger than single entities. An entity with its parameters or a process with the things it can influence can be reused as a unit with or without modification. In this way, entities with similar parameters can be substituted in for each other, or students can begin by describing a simple example, and reuse their simple substrate to make a more complex instance of the same entity as their knowledge grows.

In order to help make apparent the structural similarity or differences between entities, the relations do not take on local referents. This is consistent with Gentner's (1983) theory of structure mapping which states that analogy is possible when the structure of relationships within a situation is maintained, while the instances are changed.

3. LIBRARY FUNCTIONALITY

Students using Vmodel reuse models or parts of them through use of a model library. In the library, students store the basic model- building primitives, parts of model he or she has decided to store, any abstractions he or she has made, and any teacher or researcher created models appropriate to the curriculum.

4. REFERENCES

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