Collaborative Problem Solving using an Open Modeling Environment

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ABSTRACT
An innovative learning environment, enabling collaborative modeling activities, is introduced in this paper. ModelsCreator 3.0 (MC3) supports semi-quantitative, quantitative and qualitative reasoning during modeling activities of collaborating young children. MC3 is also an open environment in terms of primitive modeling entities, models and collaborating partners. Synchronous modeling activity can be performed at a distance using MC3, based on a mechanism of light multiple processes (reactive agents) residing in collaborating hosts.

Keywords: Computer supported collaborative learning, open learning environments, computer supported collaboration, semi-quantitative modeling

INTRODUCTION
A number of software tools have been developed during the last years that support learning through modeling (e.g. Teodoro, 1997). ModelsCreator (MC) is a learning environment that supports expression of different kinds of models, mostly for students 11-16 years old. It integrates dynamic models: semi-quantitative, quantitative, and executable decision making models as well as static qualitative models (concept maps), with special emphasis on semi-quantitative modeling (Komis et al, 2001, Dimitracopoulou et al, 1999). The most recent developments of ModelsCreator (MC version 3.0, MC3), reported here, have been in two directions: (i) Transformation of MC in an *open modeling system* and (ii) support for synchronous and asynchronous *collaborative development of models* by distant groups of young students.

OVERVIEW OF THE MC3 ARCHITECTURE
MC3 permits the collaborative building, testing and validation of models. The main functionality of the environment relates to the **Activity Space** where the models can be built, shown in figure 1. This space contains tools necessary to construct models, tools to represent models in alternative ways and tools that can run the models. In order to design a model, students have to insert primitive entities, set their properties and create relations between them. A part of the library of available **primitive entities** is shown on the left of the Activity Space, in figure 1, while on the right there is the list of available (semi-quantitative) **relations**. The relations are represented through symbols. For instance, the relations of analogy or inverse analogy are represented by the symbols:↑↑, ↑↓, (see figure 1) expressing reasoning such as: "If one entity increases, the other one might increase, or decrease". The students can use a variety of simple relations that correspond to hidden algebraic formulas.

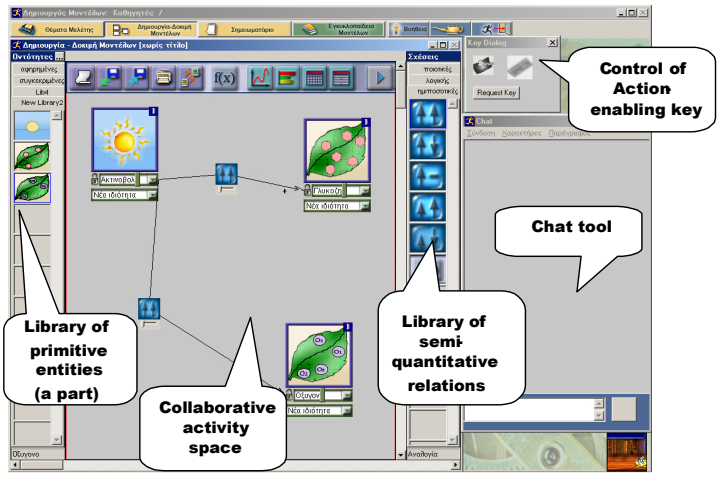

Figure 1. The ModelsCreator v3. User Interface during model building

MC3 is an open modeling system since it provides the possibility through an **entity editor** and open libraries to create new entities with various properties and behavior as well as new compound entities, models and problems. The MC3 system architecture and functionalities that enable this open character are: (i) A *repository* of publicly available modeling entities that has been created and made available to the learners community in a common Server, (ii) *Search mechanisms* and web-based interface to this repository, (iii) provision has been made to support unique identities (GUID) of any developed object (entities, models, problems) at the local host level, and entities-exchange mechanisms have been established (iv) user protocols of collaboration for synchronization of shared activity space and online update of users' heterogeneous libraries have also been defined.

Collaboration in MC3 is enabled both through asynchronous and synchronous interaction of distance partners. The integrated **chat facility**, shown on the right of figure 1, permits exchange of free-text messages between collaborating partners. Also a synchronous and asynchronous **object exchange tool** has been implemented. The Activity Space in this case becomes a drawing space of synchronous collaboration, in which one of the two collaborating partners can insert primary objects (concepts and relations), through direct manipulation. The supported protocol of interaction permits to the two partners to exchange roles, playing either the passive or the active role. The active partner is the one who can manipulate objects in the activity space. Variations and enhancements of the standard protocol involve a mechanism for interleaving text messages and action in the form of *sticky notes* (see Fidas et al. 2001). Additionally alternative protocols for controlling *ownership of parts of the model* have been devised, so that collaborating partner cannot modify parts of the solution that have been built by another partner. These also support the collaboration analysis framework OCAF, discussed in Avouris et al. (2002).

CONCLUSIONS- EVALUATION STUDIES

The MC3 environment presents many interesting new features that need to be extensively evaluated. The first phase of this evaluation, involved experimentation with specific functionalities. One experiment studied the effect of heterogeneous or missing primitive object libraries in problem solving. The result of this experiment was that the available functionality and tools allowed students to proceed with building models by collaboratively searching for missing primitive objects or develop new ones at run time, when required. One remark relating to this experiment concerns the extensive use of text-based messaging tools in this cognitively demanding activity. A second experiment involved variations on the *solution ownership protocols*. It was proven that even slight variations of the developed interaction protocols affect the use of the tools and pose new demands in terms of cognitive tasks requested by the users. More experiments and investigations are currently planned, exploring grounding mechanisms during individual and collaborative construction of new primitives (entities and sub-models) for problem solving and modeling in sciences. The creation and use of these constructed primitives during various collaborative modes constitutes also a research direction for our team. Additionally an extended large scale use by learners communities of five European countries is planned in the frame of a new European project.

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