ModellingSpace: Supporting Young Students to be Thoroughly Involved in Modelling and Collaborative Modelling Activities

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Abstract

How to really support young students in cognitively demanding modeling & collaborative modeling activities? MODELLINGSPACE environment was designed to deal with this problem. This short presentation is focused on its main design principles and features related to modeling primitives, data representations, collaborative activities' support, metacognitive support for students, as well as to teachers' support.

1. Introduction

The collaborative modelling environment called MODELLINGSPACE is developed, aiming at supporting all learning process participants: students as well as teachers. It is mainly addressed to young students 11-16 years old that are in process of scientific conceptualization. It is intended to be integrated in current educational systems and to be used in the frame of a variety of subject matters: mathematics, physics, chemistry, biology, etc.

MODELLINGSPACE* design is based on a serie of design principles (DP) derived from Science Education, Cognitive Psychology and Information & Communication Technologies in Education research fields.

2. Design principles

2.1. Modelling Support

DP1: 'A Wide Range of Variables as Modelling Primitives': In order to *encourage students to express their ideas* and proceed by their own conceptualisation of the situation under study, it is important to keep

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away from the eventual technical restrictions and *offer them a wide range of basic modelling primitives as 'variables'* (and not just the scientific ones). Thus, concerning the 'entity' that constitute one of the basic primitives for model creation, MODELLINGSPACE provides a wide spectrum: (a) '*Object-centred entities'*, which represent specific objects, with real life simulations. (b) '*Abstract conceptualized-object entities'* that represent the common characteristics of a set of uniform objects. (c) '*Abstract scientific variables'* in symbolic form.

DP2: 'Flexible Naming of Modelling Primitives': A learning environment should not be rigid in the implicated symbols. MODELLINGSPACE allows students to designate themselves the variables' names in accordance with the symbols that are currently socially constructed or accepted.

DP3: 'A Rich Range of Modelling Relations': The learning environment incorporates a simplified as well as a combined form of different independent modelling system categories. It supports the creation of *dynamic quantitative* (algebraic) models, *semi-quantitative* models and *qualitative models.* Thus, it allows the creation and exploration of models for a wide spectrum of problems and phenomena. These categories of models are able to support procedures and modelling mechanisms that derive from *different subject matters* and thus permit working *in an interdisciplinary mode*.

DP4: 'Appropriate Visualisations': The expression of all the modelling primitives that support reasoning through the *greatest and most appropriate visualization* must be supported (i.e. the entities as well as their properties or variables and the relations that govern them or impinge upon them). Thus, MODELLINGSPACE visualises the entities as real objects where the variation of properties change the appearance of the object. This visualisation is based on two kinds of images: (a) drawn images (b) Video-taped images. The environment also visualises the relations.
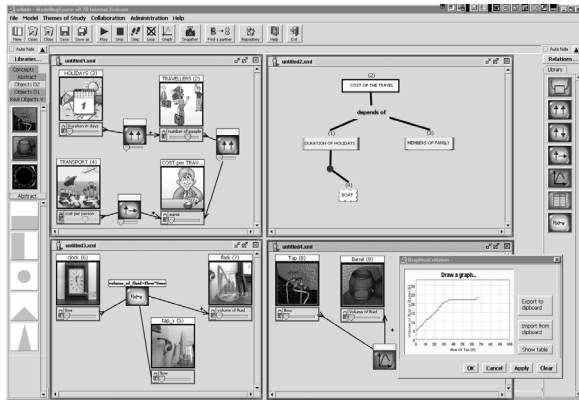
Figure 1. Modelling formalisms in MODELLINGSPACE

DP5: '*Multiple Data Representations and support of Transitions among Data Representations & Models'*: The incorporation of alternative and multiple forms of data representations (graphs, table of values, bar-charts) is supported. Furthermore, it is also important to support students to *develop cognitive flexibility* in their use. Thus, the environment allows *Drawing Graphs*, considering it as a designation mode of the co-variation between two variables. Additionally, it is possible to *Insert Values of Variables in an open table of values,* either manually, or by importing them from appropriate software (e.g. Excel). This possibility offers a powerful link to real experiments.

2.2. Collaboration Support

DP6: '*Collaborative modelling for a wide range of contexts'*: It is essential to take advantage and support the positive learning potential of all kinds of collaborative settings: *face-to-face collaboration* (in stand alone mode), *synchronous and asynchronous collaboration*, through local and wide networks.

DP7: '*Multiple Dialogue Modes for synchronous collaboration'*: Multiple and flexible dialogue modes during interaction are of great importance for collaborative modelling in rich conceptual domains [free chat, sentence-openers based chat, sticky notes].

DP8: '*Coordination & Awareness of Synchronous Collaborative Actions'*: The environment allows both free and *coordinated mode* (via an Action-key exchange metaphor) of actions into the shared workspace. Additionally, the system supports the awareness of others' actions (e.g. indicating that '*a message is typing'*), while it notifies the authorship of each item in the shared space.

2.2. Metacognition Support

DP9: '*Metacognitive Support and Scaffolding*: Given that modelling process as well as collaborative modelling process are cognitive demanding activities, at any age and for any subject matter, it is necessary to help students with both supportive scaffolding and metacognition development support (via appropriate tools).

DP9.a.: '*Promote Metaconceptual Awareness':* In order to promote *metaconceptual awareness*, the environment provides students with multiple and flexible tools, so as to facilitate the written expression of their thoughts, and to give them the possibility to return and think upon their thoughts and the evolution of their ideas (via an activity Play-back tool).

DP9.b.: *Promote Reflective Modelling by Scaffolding'*: In order to support *reflective modelling by scaffolding,* customisable templates, that address the specific goals and sub-goals during a modelling process, are created.

2.3. Teachers' support

DP10.: '*Necessary Teachers' Support*: Teachers, especially in real every-day class contexts, need flexible environments and some valuable and structured information on what happens during students' interactions.

DP10.a.: '*A system open, flexible & optional'*: When a learning environment is addressed to a wide range of students, it is crucial to be *adaptable by teachers*. This demands an *open environment* (e.g. in new modelling primitives such as entities), *flexible and optional* (e.g. with activated or deactivated functions).

DP10.b.: '*Supervision tools for teacher':* The system allows simultaneous *supervision* of students screen.

DP10.c.: '*Interaction Analysis tools for teachers':* It is important for teachers who want to diagnose students' process and difficulties, to have at their disposal **interactions analysis tools** [e.g. 'Quantitative Overview', 'Annotated Playback tool', 'Collaborative Analysis Function'], in order to analyse students' interactions during modelling or collaborative modelling activities.

3. Discussion

The design and development was based on a number of researches, focusing on the most important tools and features (the reader could consult the website

of MODELLINGSPACE [http://www.modellingspace.net].