ISEI 7
7th International Conference on Ecological Informatics
13 – 16 December 2010

Ghent University
Ghent, Belgium

Issues and opportunities for learning by conceptual modelling: a pilot case study of the new DynaLearn integrated learning environment

R. A. A. Noble[1], P Salles[2], D Mioduser[3] & R Zuzovsky[3]

[1] The University of Hull, Hull, UK - R.A.Noble@hull.ac.uk
[2] University of Brasília, Brazil
[3] Tel Aviv University, Israel

Session: Education and training in ecological informatics (Chairs: Prof. P. Salles (Brazil), P. Correa (Brazil) and B. Bredeweg (The Netherlands)

Timing: 15 December 2010, *Persconferentie Room*, 11h50-12h10 (Code ET 5)

Abstract

Learning by modelling, where students develop their understanding of concepts by building or exploring models, has been promoted as an important educational activity because it not only enables students to enhance their understanding of a topic but also to develop core skills and competences that are essential within scientific disciplines. One such modelling approach that could be applied in an educational setting is qualitative conceptual modelling, a computer-based Artificial Intelligence approach. This approach enables modellers to build mechanistic models and develop reasoning about systems behaviour without the need for numerical or empirical models. The EU-funded FP7 project DynaLearn is developing a learning environment and curricula that both furthers the technological capabilities of conceptual qualitative modelling and explores the requirements and opportunities for learning by modelling within the domain of environmental sciences. Within the DynaLearn system a number of learning spaces are available for students to develop models and model expressions at different levels of complexity using different modelling primitives. The software enables students to build models ranging from traditional concept maps, through formalised representations of systems structures and basic notions of causal relations, to qualitative models that utilise hierarchies of re-usable knowledge fragments.

This paper presents the results of small pilot case-study to test the prototype DynaLearn environment, to explore the potential for conceptual modelling activities to be used in a classroom setting and to evaluate the response of students. A small group of volunteer undergraduate students with no previous experience of qualitative modelling undertook a series of four modelling workshops exploring the capabilities of three of the learning spaces within the DynaLearn software. Three of the workshops were based around modelling tasks addressing concepts related to climate change scenarios, whilst the remaining workshop acted as an introductory session to qualitative modelling. Within each session the students were asked to undertake a modelling task and then to use those models to help with a written exercise that required them to describe the system being modelled and reason about the potential system behaviour under different scenarios. The four sessions consisted of:

1. Students creating concept maps from stimulus material (short texts and diagrams) to help them answer a given problem related to climate change.

2. Students being introduced to qualitative reasoning modelling and building models in DynaLearn, using photosynthesis as a topic.
3. Students translating a concept map on climate change into a basic causal model in learning space 2 of DynaLearn.
4. Students developing a causal differentiation model (learning space 4) from a given basic causal model (expanding causal relations between quantities from simple positive and negative relations to the formalised representations of direct influences and proportionalities).

The work undertaken by students and their experiences were recorded using four instruments. Firstly, the students' models were analysed as the output of their modelling activity, secondly at the end of each session on climate change the students were given the same written assignment requiring them to describe the system they had modelled and to reason about and explain potential behaviours under different scenarios. The written assignment was the same in each session and the answers were analysed to determine whether the different modelling activities affected their understanding, their descriptions or their reasoning ability. At the end of the series of workshops students were asked to complete a questionnaire concerning their experience and to submit a short diary detailing their experiences given a series of open questions as prompts.

The experiences of the volunteer students and the patterns observed in their modelling and written output highlighted a number of issues related to the requirements of learning by qualitative conceptual modelling. The two main issues that were observed related to the students' ability to extract and collate the important information from the stimulus materials sufficient to address the given problem and their ability to then translate that knowledge into the formalised reasoning "language" of qualitative reasoning in DynaLearn. These issue present great opportunities for DynaLearn to address through enhanced technology and development of suitable curricula and modelling activities. Whilst the first issue is not solely an issue related to learning by modelling it is an essential competency for modelling and thus an aspect that learning by modelling should address. The DynaLearn software is addressing this aspect by developing technologies allowing students to freely build models whilst receiving feedback and guidance based on comparison of their models with a teacher's model stored in an online repository. The second issue related to learning the new "language" of modelling highlights the need for modelling curricula and activities to be developed that ideally enable students to simultaneously learn domain knowledge at the same time as developing modelling and reasoning competencies. These modelling skills and competencies can then be transferred to other modelling modes and activities to learn other domain knowledge.