# How to teach environmental understanding?

## How can we increase causal and structural system understanding in environmental science education?

## First evaluation results of a conceptual modelling software (DynaLearn) in Austria.

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## Introduction

The results of the last worldwide evaluation of 15-year-old school pupils' scholastic performance (Programme for International Student Assessment - PISA) showed that only an average of 1,1 % of young people across OECD countries performed excellent in science understanding (http://www.pisa.oecd.org). The OECD average is stated at Level 3, where students can identify clearly described scientific issues in a range of contexts. Nevertheless those students cannot clearly and consistently demonstrate advanced scientific thinking and reasoning.

The aim of the DynaLearn project (www.dynalearn.eu) is to develop an engaging, interactive, hierarchically structured learning environment able to capture and simulate causal relationships across disciplines and scales based on qualitative reasoning, a research area within artificial intelligence, and allows for capturing and simulating qualitativ systems knowledge (Forbus, 1984). The evaluation of the prototype of the software represents an important part of the project that should deliver new insights in the efficiency of the features of DynaLearn to contribute to an effective, engaging and self-directed learning.

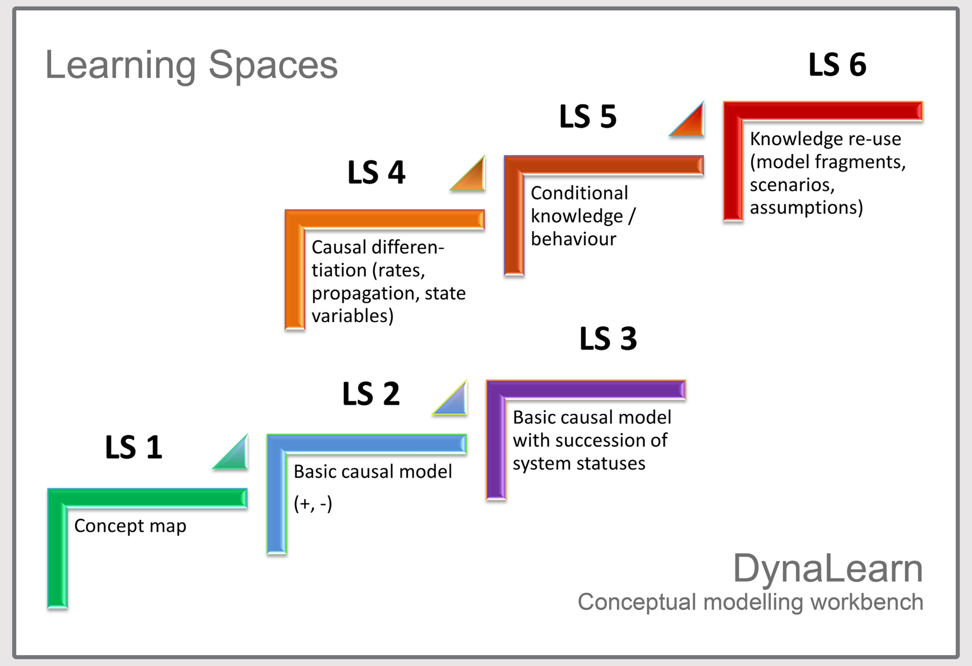


Fig. 1: Learning Spaces 1 - 6 of the DynaLearn software.

## DynaLearn Software

Based on Qualitative Reasoning, the software is organized in six Learning Spaces (LSs; see Fig. 1 and Fig. 2 as an example of LS 4) with increasing complexity. These LSs allow students to explore environmental topics at different levels of complexity taking an interdisciplinary viewpoint, depending on educational goals and settings (Bredeweg et al., 2009).

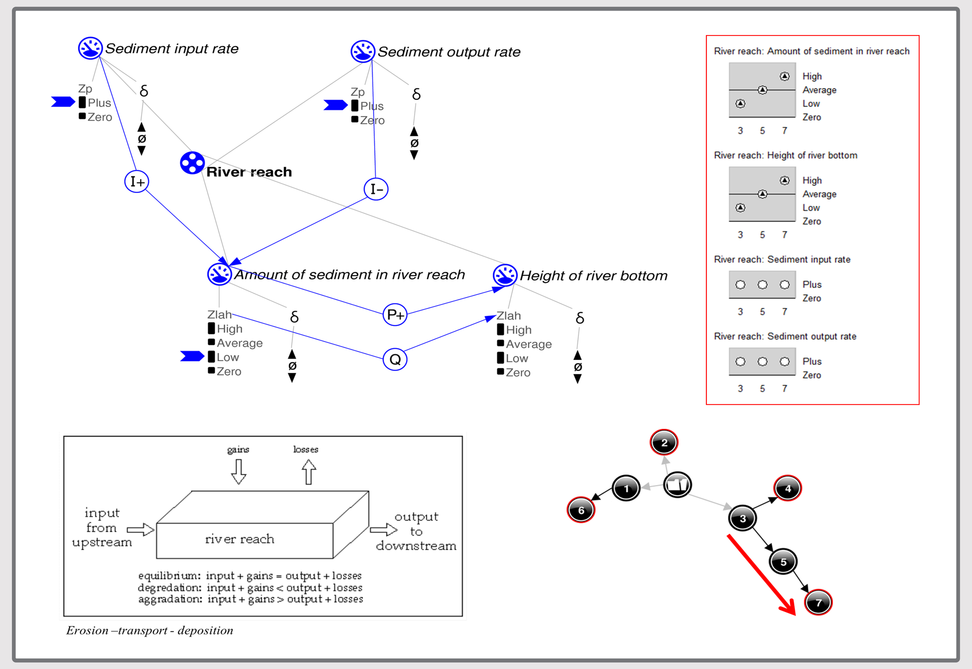


Fig. 2: Model, value history, state flow diagram and simulation path in LS 4.

A further milestone of the project is the development of software features such as 'Basic help', 'Diagnostic feedback', 'Recommendations' (see Fig. 3), etc.

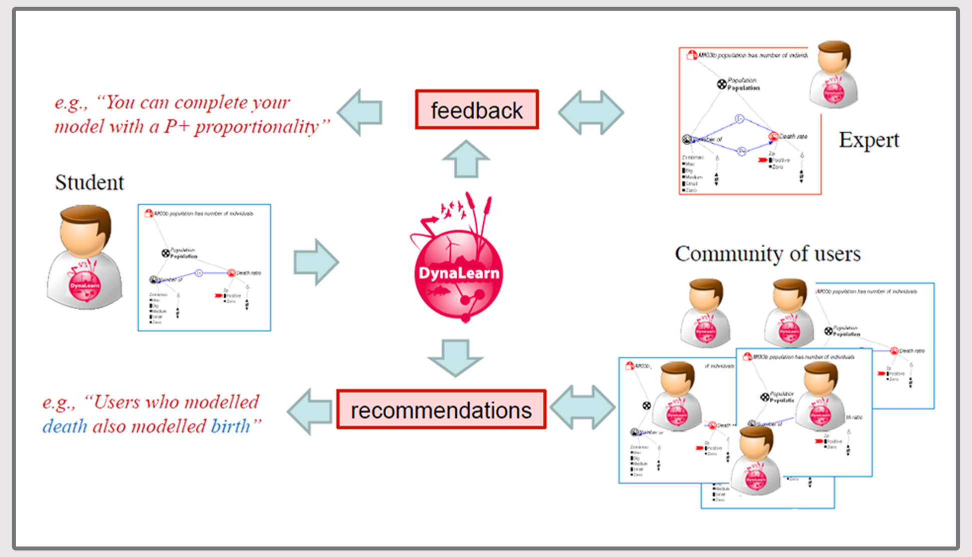


Fig. 3: Visualisation of a feedback process in the DynaLearn software.

## Software evaluation and first results

First evaluations were carried out in Austria at a secondary technical high school (i:HTL) and at the University of Natural Resources and Life Sciences (BOKU) with 31 students in total. Besides testing the effect of the modelling activity on content and structure of the domain knowledge, another important target of these pilot evaluations was to get feedback on usability. Evaluation instruments included: videotaping of the modelling activities and students' questions, pre- and post-tests to evaluate changes in students' conceptual understanding and motivation questionnaires. We hypothesized that working with DynaLearn would increase students' causal and structural understanding of environmental issues.

In both settings pre- and post-test analyses showed a significant increase in the use of causal relations as well as a significant increase of the abstraction level of representing knowledge in the post-tests (see Fig. 4 and 5).

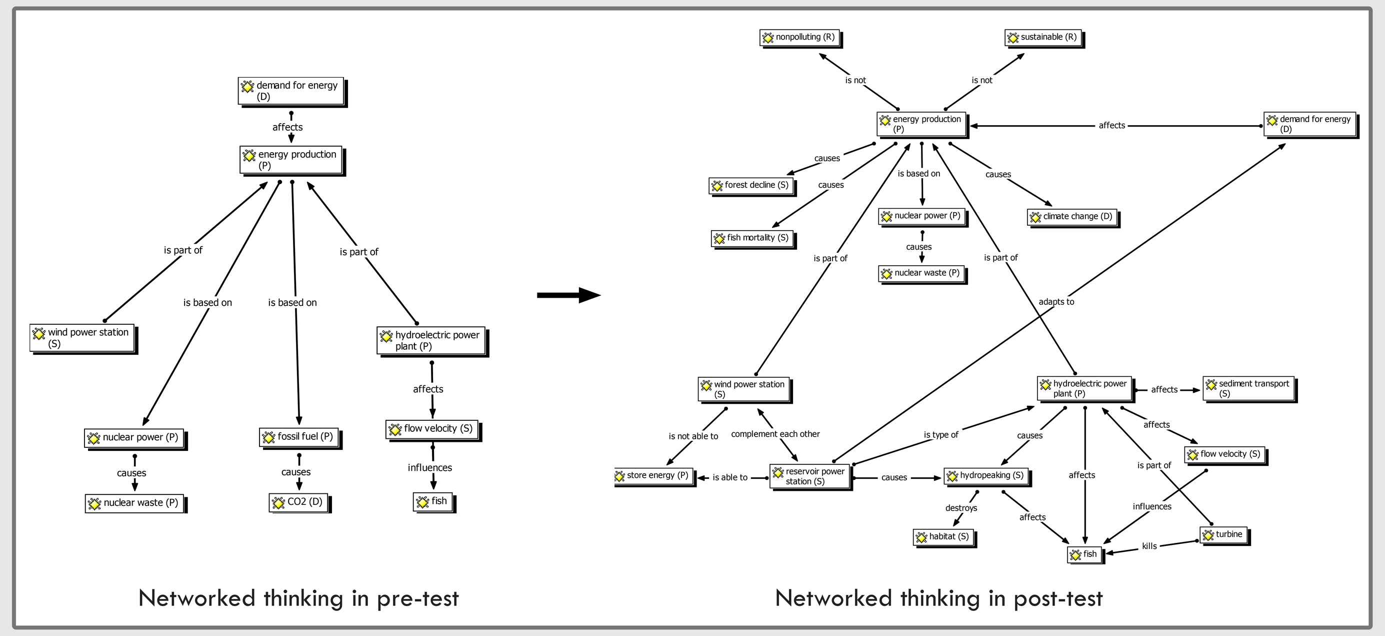


Fig. 4: Change of knowledge structure and content after DynaLearn activities, in the pre- and post-tests of an i:HTL student (analysed with Atlas.ti).

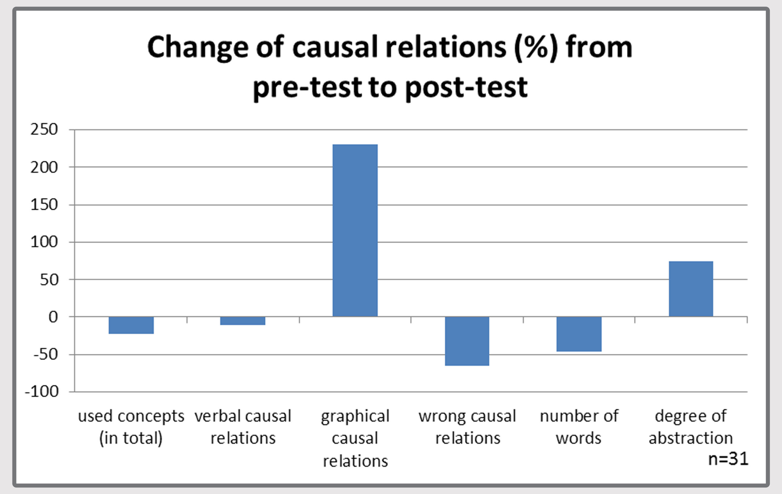


Fig. 5: Change of causal relations in percent from pre- to post-test (analysed with Atlas.ti).

The answers in the motivation questionnaires (see Fig. 6) proved that students 'highly' liked the model-based learning activity. However, the whole modelling approach was not considered as being very easy or self-explanatory. This will be improved by next software versions with the integration of further features such as Basic Help or Virtual Characters, which interact with the learners.

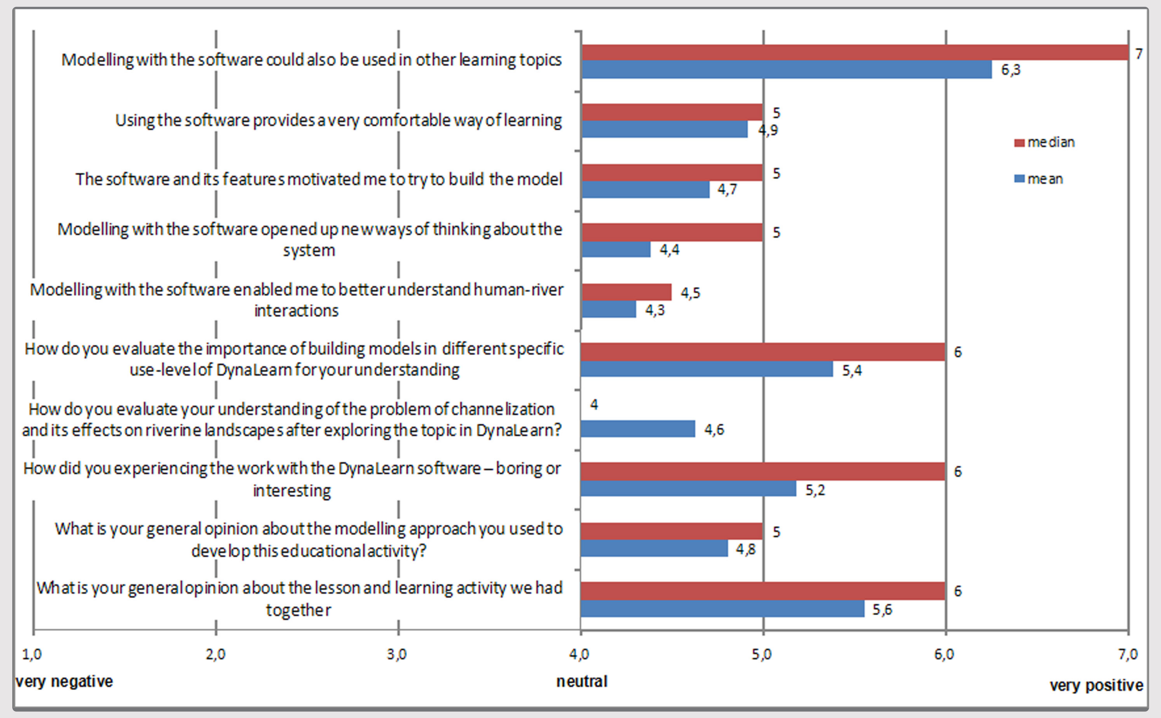


Fig. 6: Mean and median rating values per question of the evaluation questionnaire.

## Conclusions

An understanding of science and technology is central to young people's preparedness for life in modern society. The first evaluation results of the DynaLearn software showed that students increased their environmental system understanding and ability to represent knowledge in a more causal and abstract manner even after short modelling sessions. The results of the motivation questionnaires and the analyses of the videotaping clearly identify the potential of the software to be used in different fields of science education.

## References

**Bredeweg, B. et al. (2009).** *DynaLearn - Engaging and Informed Tools for Learning Conceptual System Knowledge.* Cognitive and Metacognitive Educational Systems (MCES2009).
**Forbus, K.D. (1984).** *Qualitative process theory.* Artificial Intelligence, Vol. 24, 85-168.

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