

Automating Reference-based Feedback for Learning Conceptual Knowledge in Secondary Education

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Automating Reference-based Feedback for Learning Conceptual Knowledge in Secondary Education

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Abstract

Knowledge construction tools provide students with a symbolic vocabulary to construct logic-based models. However, students using these tools typically rely on the teacher for feedback about their model, which often hampers their learning process due to limited availability of the teacher in a classroom. In this contribution, we present an automated and domain independent feedback system that effectively supports students in assessing the correctness of their model.

Introduction

Knowledge construction tools based on *Qualitative Reasoning* have been developed for education [2, 3]. These tools use a symbolic vocabulary to support students in constructing their understanding [4, 5]. DynaLearn is such a tool and focusses on learning about systems and their behaviour [1,6]. Students formulate hypotheses, create cause-effect models, assess their models through simulation, reflect on the outcomes, and keep further developing their understanding until reaching a desired result.

Currently, the feedback provided by DynaLearn is limited to simulation outcomes. The student has to either self-check or ask for help from the teacher or a classmate when support is needed, e.g. to understand and interpret the simulation results. Hence, an outstanding challenge is to provide students with automated feedback throughout the modelling process and optimise their learning experience.

In this thesis, a feedback module is presented for the DynaLearn environment, focussing on use in secondary education. The feedback takes reference models as the basis for providing feedback about correctness. The feedback module has been evaluated with students on usability, utility and comprehensibility.

Feedback module

In many cases, students in secondary education are required to learn a specific model of some knowledge system. Because of the specificity, recommendations can be made, based on a reference model created for a specific learning goal and considering the students' level. Since the correctness of the model has already been validated by the teacher, recommendations based on such reference models are relevant to the student.

An automated, domain independent, feedback system has been developed and implemented that compares the student model to a predefined reference model, maps elements from the two models that match, identifies deviations, and communicates the feedback visually using different icons and colour codes (Figure 1). The feedback module provides students with immediate feedback on the correctness of model elements. Feedback is communicated visually, using icons to convey distinct information about the correctness of the model, the need for the addition, and removal of elements or relations.

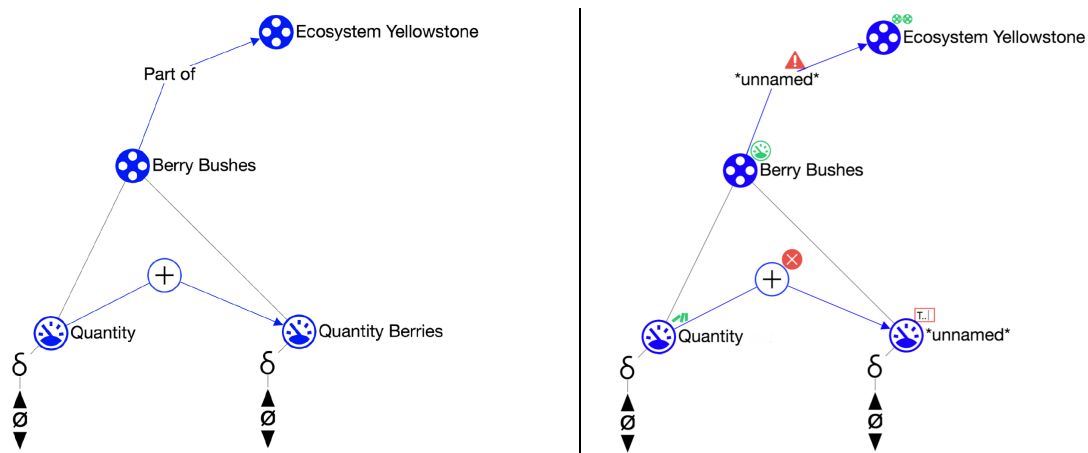


Figure 1. Example of the communication provided by the feedback module. LHS shows the reference model. RHS shows the student-created model and the feedback the student receives. The subject matter concerns trophic cascades using information about Yellowstone park (USA). The diagram shows the initial part of the full model which has over 50 ingredients.

Results and Conclusions

An evaluation study was done to assess usability, utility and comprehensibility of the feedback module. Participants (N=7) completed a biology assignment on trophic cascades and answered questionnaires. Three out of the seven participants were high school students (age 15-18), while four were university students (age 19-27). The high-school students received pre-university education with a science and mathematics track. The university students followed a science or technology major.

The reception of the feedback module was positive. The participants in the evaluation study considered the feedback useful and argued that the feedback helped them improve their model. This also became apparent when looking at the number of questions they asked the teacher. The participants were asking increasingly less questions about the correctness of their model towards the final stages of the modelling process and relied mostly on the automated feedback to improve the model.

Some confusion occurred regarding the colour-codes used. After the teacher reminded the participants to carefully look at the differences between the icons and consider their meaning, the students started using them effectively.

The current implementation covers 50% of the elements in DynaLearn, which is sufficient for the first modelling level (standard). For full use in education, it will be necessary to also implement feedback for the second (advanced) and third (advanced+) level. Furthermore, additional flexibility could be researched by comparing the student created models to more than one reference model.

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