Contradictions as an anchor for providing help during collaborative learning

RACHEL OR-BACH[1] AND WOUTER VAN JOOLINGEN
Graduate School of Teaching and Learning, University of Amsterdam
Wibautstraat 4, 1091 GM AMSTERDAM
{rachel, wouter}@ilo.uva.nl

Abstract: This paper deals with support intervention for collaborative learning during qualitative modelling tasks. Modelling activities involve search for coherence with aspects of the real phenomenon, the underlying assumptions, and the modelling formalism. So, the support interventions are oriented towards the identification and discussion of respective types of contradictions within collaborative modeling and debugging processes. Students interact with the learning environment by using visual tools for modelling, by running a simulation of the phenomenon, and by communicating with each other by special tools and free text. The system is designed to detect contradictions, to check learners' input for evidence of ignoring contradictions, and to generate respective interventions.

INTRODUCTION

Considerations about when and how to provide help for learners depend on the domain, the setting, and mostly on the underlying pedagogical philosophy. We describe consideration for help provision in a collaborative learning setting, where the goal is to encourage help provision by peers (to each other). In collaborative learning settings, help seeking and help provision can be naturally intertwined in the learning process, and that what we are trying to support. Our learning environment deals with modelling tasks based on simulations that can be conducted for discovery and validation of an underlying model. The learning environment is based on SimQuest (Van Joolingen, King & de Jong, 1997) with the addition of dedicated visual tools for modelling (Van Joolingen & Lohner, in press). This visual representation was designed to support the gradual qualitative process of modelling. The learning environment is intended for junior-high students during their science class, and the students are expected to work in pairs over the net. The following guidelines directed our design considerations and decisions regarding help or support provision:

- Trigger processes that mutually enhance each other: a) Individual and group activities, b) Content-oriented and communication-oriented interactions.
- Interventions that are less obtrusive and which invoke doubts, justification, reflection, argumentation; any process that contribute to learning.
- Support the individual learning through the collaboration.

[1] On leave from Emek Yezreel college, Israel orbach@yvc.ac.il, orbach@tx.technion.ac.il)

We believe the most appropriate way for employing the above guidelines is by anchoring help provision in a context where a clear contradiction (or difference) can be perceived by students. We looked for anchors that are suitable for both naturally invoking discussion and also suitable for anchoring communication and cognitive support. The respective required reasoning deals with the detection of such opportunities, taking into account context and history elements.

INTERACTING WITH THE LEARNING ENVIRONMENT

Interaction possibilities within the learning environment determine both the range of opportunities for triggering active learning and the range of data the system can use for help provision decisions. The main elements of the learning environment are:

1. *Modeling tools.* A formalism consisting of a set of visual objects and rules for constructing qualitative models.

2. *Simulation possibilities.* Learners can determine which variables' relation they want to watch graphically through simulation of the phenomena with a respective underlying model.

3. Communication tools and protocols. A learner workspace consists of the visual modelling environment and the simulation possibilities. Students alternate between their individual workspace, where they can try and modify their own ideas, and a shared one. It is possible to copy and paste elements between environments. The shared environment is like the individual ones, but has an additional communication panel. This panel includes an area for inserting text and several menus for tagging the text. The communication in the shared environment is based on pointing to an element in the environment for which a respective context sensitive menu (hierarchical one) is opened. Students can enter free text for communicating regarding that menu element (usually a property of the object), and then they have to tag the text (choosing from a respective menu) to convey the input purpose. This has similarities to the idea of Collabicons (Singley et al., 1999) and the C-CHENE interface (Baker and Lund, 1996). The pointing and tagging activities support students in structuring and focusing their inputs; and also gives the system required information for "understanding" the students and for providing adapted support.

THE ANCHORS - EXPECTED CONTRADICTIONS

Debugging is a major activity of modelling. We expect learners to look for coherence with regard to the following sources of possible contradictions. We apply the term contradiction in a broader sense to include also obvious differences. (a) Contradictions that relate to the formalism of the (visual) modelling environment, definitions and construction rules. (b) Contradiction between the learner(s) suggested model (as described by the visual representation) to the real model (that the learner can explore via the simulation). The actual context can vary here with respect to whether the learner(s) performed the relevant simulations before. This will affect the content of the help intervention. (c) Contradictions (differences) between the models suggested by the two partners. These differences are expected to serve as hints for learners to look for real contradictions as the two previous types.

DETECTION OF OPPORTUNITIES – THE REQUIRED REASONING

The visual tools of the environment, both for modelling and for simulation, provide the opportunities for learners to compare and "see" contradictions. The collaborative setting provides another mean of potential feedback, a feedback coming from a peer when the contradictions were not "seen" or were not understood. We believe that only when these do not lead to a progress,

some other (minimal) intervention should follow, pointing to a way to "see" the difference or contradiction. An opportunity for a support intervention is when a contradiction exists and the system has evidence that the learners ignored it. So the main reasoning procedures deal with the detection of differences and contradictions, and with some analysis of the communication. The analysis of the communication involves two sources of information: the structured tools that the learner used (pointing, menu item, tags) and the free text input. The free text input is analysed by respective keywords generated by the representation of the learner model and filtered by the choices within the structured communication tools. More reasoning is required for generating the help that points to a difference/contradiction or suggests the use of a simulation to discover the contradiction. The first is quiet strait forward after the detection and analysis, but the second requires some more context and history analysis on one hand, and comparison of the learner's model and the real model, to suggest a critical experiment, on the other hand.

DISCUSSION – HELP PROVISION CONSIDERATIONS

Our approach for supporting collaborative learning in modelling tasks is directed more towards the modelling tasks than the discourse, and more towards individual learning processes within collaboration than towards a collaboration product. Modelling is a complex task that requires initial support. We anchor the support interventions in contradictions, similar to the COLER system (Constantino-Gonzalez & Suthers, 2001), but with a different emphasis and range of conflicts (contradictions). Modelling activities involve search for coherence with aspects of the real phenomenon, the underlying assumptions, and the modelling formalism. So the support interventions aim at focusing learners' activity on the identification and discussion of such contradictions in a collaborative debugging process. The internal representation enables the detection of such contradictions. These contradictions can be automatically indexed according to topic and type of contradiction to construct a relevant intervention. A hierarchy of importance for both topics and types of contradictions directs the choice of the generated and presented intervention. The topics hierarchy is used for supporting the modelling process as a combination of bottom-up and top-down approach, by directing focus on input variables and their effects and on state variables and how they are affected.

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