

Promoting Collaboration and Discussion of Misconceptions Using Open Learner Models

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Abstract. This paper describes the use of independent open learner models that prompt spontaneous collaboration amongst students, and suggest that these results could be built upon in systems that offer more explicit support for collaboration and student interaction. We focus in particular on the promotion of learner discussion around their misconceptions.

1 Introduction

Misconceptions have been investigated in a range of subjects, with the goal to recognise and understand learner 'knowledge' (e.g. [1],[2],[3],[4],[5],[6],[7]). While information about misconceptions is regarded as important to help teachers improve or target their teaching [8], information about misconceptions is also argued to benefit learners [9], and has been found useful in open learner model contexts [10].

Open learner models (OLM) are learner models that are 'opened' to the user in a form that they can understand. Common model presentations include skill meters and concept maps (e.g. [10]). Externalising the learner model can help prompt reflection and metacognition [11]. Previous research suggests learners are interested in knowing their misconceptions [10]. Furthermore, work also shows that where learners can optionally release their learner model to peers, spontaneous collaboration can be prompted, including discussion of misconceptions [12]. This finding was with an independent OLM: an OLM independent of a full intelligent tutoring system - there is no system guidance (for individual or collaborative learning), beyond presentation of the model to the user (and their peers, if applicable) [10]. Therefore, in this paper we consider whether an OLM could provide further support or a focus for collaboration in environments where collaborative interaction is explicitly facilitated.

2 Supporting Collaboration with Shared Open Learner Models

The potential for OLMs to prompt discussion of conceptual knowledge and misconceptions was suggested based on results of a pen-and-paper task with pairs of co-present students, after they had individually completed the same task [13]. The discussions (12 students / 6 pairs) demonstrated unprompted self-explanations and ex-

planations to the learning partner; requests for explanations; statements of disagreement; self-questioning; and both collaboration and peer tutoring. The majority of students demonstrated increased understanding at the end of the experimental session.

A fully deployed independent OLM that indicates level of knowledge of a series of topics or concepts using skill meters, with specific statements of inferred misconceptions - e.g. *the '=' operator is used for comparison* (C programming) - has also demonstrated that students can be supported in collaborative face-to-face interactions even though it offers no explicit support for collaboration [12]. Students can choose whether to release their learner model to some or all peers in their course; whether to release this information named or anonymously; and whether to release it in the same way (named or anonymously) to different users. It was found that students did release their learner models to each other; that they undertook spontaneous face-to-face collaborative discussions based on the contents of their respective learner models; and that such discussion often focused on resolving misconceptions. This included interactions amongst students who did not usually discuss their work with each other [12].

OLMs have also been used to support teams of students working together on group projects, allowing students to reflect on how group members are contributing to the project [14]; and in distance learning to help overcome the feeling of isolation, and to allow students to compare their progress to that of others [15].

3 Step-By-Step Presentation of Misconceptions

AniMis uses the OLMlets [10],[12] learner modelling process (which builds a simple weighted model from multiple choice questions and permits viewing the OLM at any point during an interaction), but provides additional detail in the OLM. It allows students to explore step-by-step descriptions of their misconceptions and compare these against step-by-step descriptions of the corresponding correct concepts, and has so far been implemented for C programming and chemistry. In each case, descriptions are available in text and animation, as in Figure 1. The top left of Figure 1 is a step-by-step description of a concept; top centre is a simulation of the execution of a do-while loop; top right is an animation of a misconception. The bottom left shows a text description of a concept in chemistry; the lower middle gives an animation of a concept (simulating the chemical reactions taking place inside the cell, causing the flow of electrons and producing electricity). On the bottom right is an animation of a misconception (showing the electrons travelling through the solution to complete the circuit).

An evaluation with 14 users was undertaken with the programming version of AniMis during a one hour lab. Two users had no misconceptions, so this study uses data from the 12 participants who held at least one misconception. Participants were from Electronic, Electrical and Computer Engineering, University of Birmingham, UK. They were taking an Adaptive Learning Environments course, and had previously completed a C programming course. Log data and questionnaires were analysed, and the lab session was observed by a researcher. In this study, the feature to release the learner model to peers in OLMlets (see [12]) was not available.

The logs reveal 134 OLM viewings. All users accessed their model, with 2/3 viewing it more than 10 times (mean 17.625, median 11, range 2-31). Questionnaires indi-

cate a majority of users found the OLM beneficial, but animations more useful (10 of the 12 users for misconceptions, 11 for concepts, no negative responses) than text (7 for misconceptions, 9 for concepts, 1 negative response - for concepts only). Although not instructed or requested to do so, students were observed to spontaneously discuss their understanding and learner models with each other. Typical exchanges included asking for explanations when misconceptions were identified; and more knowledgeable students spontaneously offering explanations or tutoring. In particular, some of the weaker students thought their misconceptions correct because the code output generated matched the correct answer, but then recognised the explanations of stronger students. These discussions typically involved 2-3 students who formed a group, mostly staying together for the session. Only 2 (of the 14 present) worked alone. On very few occasions did students ask for the correct answer, indicating a willingness to engage in collaboration and learning. Most discussion focused around animations.

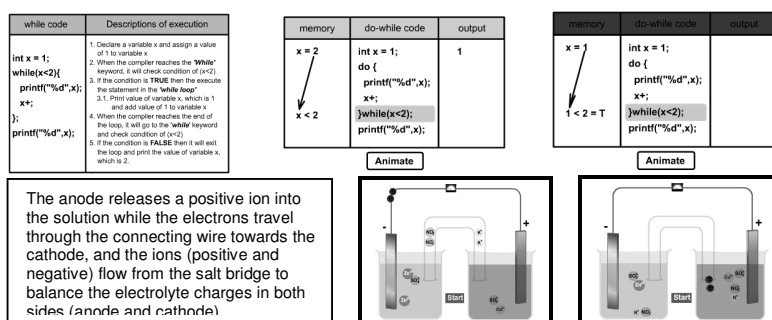


Fig. 1. Learner model views for C programming (upper) and chemistry (lower)

4 Summary and Conclusions

We have described an example of promoting spontaneous face-to-face discussion of misconceptions using OLMs. Previous work demonstrated face-to-face collaboration prompted simply by allowing students to release their models to each other [12]. The current study showed that even when users could not release their models to peers, they still came together spontaneously to discuss their OLMs, despite no instruction or suggestion that they should do so. Students claimed to find the OLM representations helpful. We therefore suggest that OLMs could be useful in prompting collaboration and discussion of misconceptions in a range of contexts - where OLM presentations are simple (e.g. [12]) or detailed (AniMis); where the models can be shared, or not released to others. In addition to the independent OLMs introduced above, this approach may also be useful in adaptive learning environments that explicitly facilitate collaboration, as the principle of providing a starting point for learners to collaborate and discuss their knowledge, still applies. Presenting learners with their inferred misconceptions and encouraging them to discuss these with each other, could be a powerful focus for the design of collaboration support. For example, concepts and

(possibly multiple) corresponding misconceptions amongst learners, could be presented in a group model for online or face-to-face discussion, with system prompting as appropriate for the specific collaborative learning environment. Alternatively, system guidance for pairs/groups based on the kind of spontaneous learner groupings observed here, using the individual models of those participating, could be offered. Given the range of subjects in which misconceptions are found, we anticipate the approach to be broadly applicable. Future work will consider such issues with reference also to the nature of the misconceptions held and conceptual change (see [16]).

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