

Preface

"Open Learner Models: Research Questions" Special Issue of the IJAIED

WHAT ARE OPEN LEARNER MODELS?

The learner model is central to an adaptive educational system, as it is the model of the learner's understanding (and possibly also other attributes such as their goals, motivation, learning preferences, etc.), that enables a system to adapt to the individual user's current learning requirements. Traditionally, the learner model has been closed to the learner since its primary purpose, as indicated above, has been to allow a system to adapt to the individual's needs. For several decades now, the Artificial Intelligence in Education community has been developing methods for modelling learners, and dealing with the dynamics and potential inaccuracy of learner models. One promising approach to improving the accuracy of the learner model is to *open* the contents of the model to the learner it represents, to allow them to suggest additional information, or to propose corrections to entries, thereby helping to maintain the accuracy of a system's model of the user's knowledge and other attributes relevant to the specific educational context. A second benefit of this interactive approach to learner modelling is that the learner model now plays a new role – not only can the learner contribute information to help increase the accuracy and therefore the utility of their learner model for adaptation purposes, but the model can also become a learning resource for the student in its own right. Such an *open learner model* (i.e. a learner model accessible to the learner modelled) offers the learner a perspective on their understanding that is not usually available to them, which can facilitate reflection on their knowledge and on the learning process more generally, as students must carefully consider their knowledge state before suggesting changes to their model. Furthermore, even non-interactive open learner models (that is, learner models that are *inspectable* but not changeable by the user) have the potential to prompt learner reflection and metacognition in a similar manner, as they confront the learner with information about their understanding which is likely to provoke some kind of cognitive reaction from them.

In addition to being available to the learner being modelled, learner models can also be opened to other parties, such as instructors (to help them better understand the needs of their students); to peers (to enable learners to compare their knowledge and progress to that of other learners, and to facilitate collaboration amongst a co-present or distributed group of students); to parents (to inform them of their child's progress or help them to help with their child's learning); and potentially also to other stakeholders in the education process.

To date there have been two general approaches to open learner modelling research: (i) opening the learner model of an adaptive learning environment in order to investigate a range of issues relevant to the open learner model in a more traditional setting of a complete adaptive system; and (ii) developing open learner models distinctly from a full system in order to investigate their potential without the confounding factors of a larger system. These approaches can be used to inform the design of open learner models within a complete adaptive learning environment or (in the latter case), to suggest the likely utility of new learner models in isolation, which have a role in promoting formative assessment while leaving the control over learning with the student. In the special double issue of IJAIED we see both approaches, but with a strong bias towards full systems, reflecting the balance of current research.

RESEARCH QUESTIONS FOR OPEN LEARNER MODELLING

The field of open learner modelling is still relatively new, and although a number of successful systems have been demonstrated, there remains much work to be carried out. Important questions include:

Presentation of open learner models

- In what contexts are simple skill meters adequate as open learner models? Skill meters have been used primarily in adaptive navigation support and as a means to promote formative assessment - might there also be other useful purposes for these more straightforward open learner model formats?
- The skill meter is the most common method of presenting simple open learner model information, but is this the best method? When might other simple open learner model formats be appropriate?
- How can more complex open learner models best be displayed to the learner? A variety of formats have been used, including text descriptions, hierarchical tree structures, pre-requisite relationships, concept maps, and graphical representations of Bayesian networks. Are some structures better suited to specific purposes for accessing the learner model? Or is the 'right' open learner model format more dependent on the structure of the domain, or the nature of the task, etc.?
- How much choice should a learner have over the method of viewing their learner model? To what extent is this determined by the domain, the purpose of viewing the learner model, the level of interactivity with the learner model, the particular user group, or the specific task or aims of the system in which the open learner model is deployed? Or to what extent might the display format be related to individual preferences and abilities?
- Which learner model attributes should be shown to the learner, and when? What level of detail is useful? Which learner model attributes should a learner be able to interact with, and possibly change, in the more interactive open learner modelling approaches? What features of a system may be important to determine the level of control a student may have over access to their learner model data?
- How can interpretation of the contents of an open learner model be supported in a way that can facilitate reflection and metacognition, and thereby further learning?
- When is it important that the learner fully understand the role of the learner model in an adaptive system, and when might a less complete appreciation of learner modelling be sufficient?
- Under what circumstances might it be useful to show learners data about their affective state in systems that model emotions or other affective attributes?
- How can learners be motivated to use open learner models, in order to benefit from their availability? Can this be achieved without the system needing to make all decisions regarding when a learner model should be displayed?
- What kind of learning gains can be achieved with the availability of an open learner model, and to what extent may this depend on the specific features of the open learner model used?

Open learner models for groups of learners

- What are the implications for model presentation and interaction such as suggested above, when learner models are available also to other users, and not just to the learner that the model represents?
- How do group models differ from individual models? What characteristics should be used when modelling groups, what characteristics when modelling individuals, and how do these differ?
- How can we support learners undertaking collaborative tasks with group models and/or models of individual peers, and how might this differ from the use of learner models in individual learning contexts?
- How can we deal with the privacy issues arising when an individual's learner model may be seen by other users? Are the issues different for the release of an individual model, and when the learner model data contributes to an aggregate group model?
- What will be the reactions of learners to the learner models of others, and to the possibility that other users may be able to access their learner model information?

- What differences will there be between learners' acceptance of the availability of their learner models to different types of user, such as instructors versus peers?

Open learner models for different learner types

- What differences might exist in the requirements for open learner models for school education at different ages, and university or other adult learning contexts?
- What differences might exist in the requirements for open learner models for learners from different educational cultures?
- What differences might exist in the requirements for open learner models for learners of different levels of ability?
- What differences might exist in the requirements for open learner models for learners with different learning goals, or different levels of motivation, etc.?

Many of the above issues remain to be addressed. Through stating these questions we hope to prompt interest and new work on some of the key areas. Perhaps the most important question is: "What kind of open learner models do students actually use?". This special issue draws together findings of some of the early work to date, to serve as a foundation upon which to build in the investigation of the many remaining topics.

SPECIAL ISSUE OF IJAIED ON OPEN LEARNER MODELS (PART 1)

The special double issue of the International Journal of Artificial Intelligence in Education is the first journal special issue on open learner modelling. The special issue is in two parts. This issue (part 1) starts with a paper giving an overview of current research in open learner modelling from a range of perspectives, by Susan Bull and Judy Kay. The paper offers a framework for the design and analysis of open learner model systems that aims to facilitate fuller description of open learner models in order that they may be understood and contrasted more easily, and that the relevant features may be used as guidelines for consideration in the design of new open learner models. The framework includes purposes for opening the learner model, and the methods of achieving these purposes. As a general paper, it discusses a range of the issues introduced above.

The second paper by Antonija Mitrovic and Brent Martin considers how a very simple inspectable learner model format (the skill meter), built on top of a complex model, may be successful in supporting learning and metacognition, and facilitating the selection of appropriate problems, for university level learners. The particular focus is on the learner's ability to assess their own learning. This work has been carried out in the context of constraint-based tutors, but the results may also apply to other types of adaptive learning environment. Positive outcomes for simple open learner models such as these indicate the potential for even very straightforward open learner models, which are easier to implement. The potential for more detailed open learner models to support learning and self-assessment may be even greater. This paper considers in particular the above questions of the adequacy of simple skill meters; the effects of open learner models on learning for both more and less able students; and when learner model information is available to learners.

The third paper by Zhi-Hong Chen, Chih-Yueh Chou, Yi-Chan Deng and Tak-Wai Chan investigates an interesting method to encourage children to use an open learner model: embodying the model in a virtual simulated pet which the child can look after. The aim is that children can be motivated to learn through the need to care for their individual pet (their own learner model), or their team's pet (the group learner model). This paper considers the above issues of motivating learners to use open learner models, and supporting both individual and group/collaborative learning. The early results reported in the paper suggest the potential for open learner models designed specifically to appeal to children (here, eleven year olds), to motivate children to learn.

The final paper in this first issue of the double special issue on open learner models is by Josephine Tchétagni, Roger Nkambou and Jacqueline Bourdeau. Their paper considers the issue of learner reflection explicitly, not only after the learner model has been built (reflection-on-action) but also during the process of obtaining the learner model (reflection-in-action). The paper

describes tutoring dialogues which follow reflection strategies to engage learners in interaction that helps them become aware of their knowledge (of the Prolog language in this case). The approach enables students to inspect and interact with their learner model more directly, with the possibility of changing the contents of the model through taking a 'control exercise' to justify their viewpoint if they disagree with the model data. This paper contributes to approaches that deal with planning the interaction with an open learner model and provide the means to support learning by fostering reflection through an open learner model approach.

In the next issue we will introduce the second set of papers in this special double issue, and further reflect on open learner modelling. We would like to conclude this introduction to the first volume with a brief introduction to the Learning Modelling for Reflection (LeMoRe) special interest group.

LEARNER MODELLING FOR REFLECTION

The "Learner Modelling for Reflection (LeMoRe)" group is a community of learner modelling researchers who share an interest in the use of learner models to promote learner reflection. One of the key methods of achieving this aim may be through open learner modelling: allowing the learner to view and perhaps even interact with their learner model contents can provide a focus for reflective thinking. Similarly, access to the models of peers can help students appreciate their knowledge in relation to that of others; and learner models open to instructors or other parties can help those others to better understand learners and their needs. New LeMoRe members are welcome, and new examples of open learner models and other approaches to stimulating learner reflection are sought. For further information please see <http://www.eee.bham.ac.uk/bull/lemore>.

Susan Bull
Vania Dimitrova
Gord McCalla
(Guest Editors)