Negotiating Individual Learner Models in Contexts of Peer Assessment and Group Learning

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Abstract. This paper introduces learner model negotiation not only as a means to increase the accuracy of the learner model and promote metacognitive activities as in past examples, but also as a way to help learners correct peer assessment entries in their learner model, that they consider inaccurate. While open learner models are not new, and negotiated learner models have been developed before, in today's learning contexts of potentially big data from many sources including other learners, some kind of approach to managing the data as well as helping learners to understand and accept it, or correct it, is needed.

1. Introduction

Benefits of a range of approaches to learning in groups have been argued (e.g. [9]), and there is strong interest in the field of Artificial Intelligence in Education in developing useful support for group learning [18]. Peer assessment and feedback have also been advocated as beneficial to the learning process (e.g. [27],[30]). We introduce a negotiated open learner model (OLM) approach to supporting students in the peer assessment situations that are becoming more common in today's learning contexts.
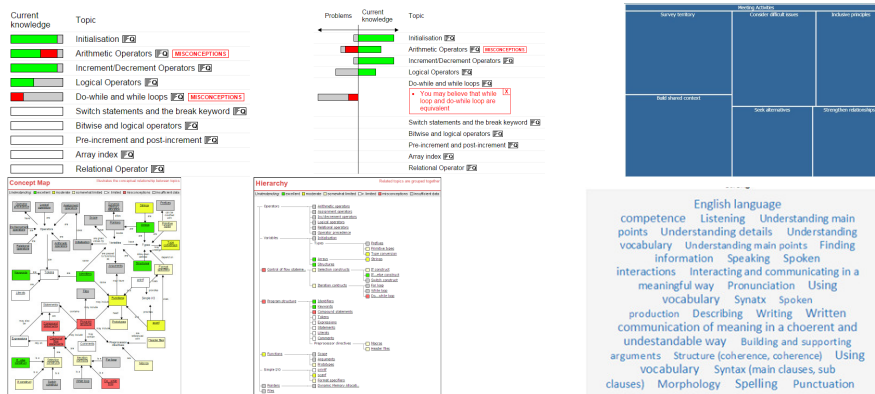

Fig. 1. Examples of open learner model visualisations

OLMs are learner models that are externalised to users in an understandable form, often to support collaboration or metacognitive behaviours [4]. Figure 1 gives OLM

visualisation examples of simple skill meters [2], structured concept map and hierarchical tree [20], and newer visualisation approaches of overview-zoom treemap and word cloud [3]. While OLMs to support group learning have been developed (e.g. [1],[2],[6],[28]), the range of activities a student may be engaged in will likely include individual activities. Thus, in this paper we reflect on individual learner models that may be used in a group context. We focus in particular on situations in which peer feedback or assessment contributes to the individual learner model, which may follow the production of an artefact for assessment, or participation in a group activity.

2. OLMs and Peer Assessment in Modern Learning Contexts

Learner modelling has broadened, now being found in contexts with rich collections of digital materials [14]. Recent advances in learner modelling have aimed to address the use of new technologies, e.g.: learner models holding diverse data from different sources [3],[7],[21],[22]); combining e-portfolios and viewable learner models [23]; and OLMs to help learners monitor progress and plan their learning in MOOCs [15].

Peer assessment has become more prevalent in modern learning contexts such as MOOCs [17],[25] and e-portfolios [12],[31]; as well as individual online systems that allow peer assessment and feedback to be given and received [19]. OLMs that include peer assessment and feedback have been proposed [11], and developed (see [3]) in the context of peer assessments (numerical, contributing to the learner modelling algorithm) alongside automated data from a variety of external applications, and feedback (non-interpreted text, to help explain the numerical value of a peer assessment to an assessee). However, although there are many learning benefits for both peer assessors and assessees, there can also be cases of motivation decreasing if a student considers a peer assessment to be unjust [17]; or a learner feels there to be a lack of effort/attention from a peer assessor [10]. Another issue that may cause concern is the outcome of group assessments where there has been unequal contribution from group members [24]. For example, a student who engaged minimally in a group activity or project may receive the same assessment as the other participants. Experiences such as the above can cause strong emotional responses, and a method for learners to either understand learner model representations originating from peer assessors, or to challenge them, would help to relieve this frustration. The solution should allow individuals to understand the reasons for peer assessments and the system's perspective on them, as well as justify why they believe these representations or reasons to be inappropriate. We address these problems in the context of the LEA's Box OLM, where a learner model negotiation mechanism is being developed (based on [5]).

3. Maintaining the Learner Model through Negotiation

Building on the Next-TELL OLM [3], the LEA's Box learner model data may originate from a range of applications. In some cases, activities may be completed away from any tracking software. To address the latter, teacher, self and peer assessments can be entered alongside automated assessments. However, these may themselves

differ in quality according to effort, experience and expertise of the assessor. While a learner may accept an automated assessment, or assessment by a teacher, they may be less happy with peer assessments and, indeed, may retain a negative attitude towards peer assessments over teacher assessments [13]. Even though a single peer assessment may ultimately contribute little to the value(s) in their learner model, this negative affective state may remain strong.

Some OLMs have allowed the learner model to be negotiated, where student and system have the same powers and negotiation moves [5],[8],[16]; or to be discussed in some other way, e.g. one partner has greater control over the discussion outcome [26],[29],[32]. Advantages of discussing or negotiating learner models include: the possibility to increase the accuracy of the learner model by allowing the learner to challenge the representations [5]; motivation may be increased by offering an alternative task [26]; significant learning gains may be achieved as a result of the negotiation process [16]. We here add a new benefit resulting from the inclusion of peer-entered data in an individual's learner model, for the increasing number of contexts in which multiple sources of data, including human contributions, are incorporated in the learner model. As well as increasing the accuracy of the learner model, individuals have the opportunity to redress any perceived injustices introduced by peer assessment.

Discussion of learner models typically involves moves such as agree/disagree; requesting information; challenging the other partner (learner or system); stating one's viewpoint; and justifying one's viewpoint by referring to evidence. For example:

- LEARNER: My value for [multiplying matrices] should be [higher].
- SYSTEM: Your last [five] attempts in [OLMlets] showed that you have [multiplied the corresponding items in each matrix]. You are adopting an approach used to [add matrices] when you are trying to [multiply matrices].
- LEARNER: I have since [participated in peer discussion].
- SYSTEM: Please [multiply] the following: ……

This example shows a student-initiated attempt to change a learner model representation (square brackets indicate variables). Having looked at their OLM, the learner notices that they disagree with the strength of the value for multiplying matrices. The learner has the misconception that the process mirrors that of adding matrices. The system has modelled this misconception, and is able to provide the evidence to back its inferred value – that the user's most recent attempts at this type of problem using the OLMlets system [2] illustrate the misconception. On receiving this evidence, the learner may accept the existing value or try to persuade the system further (in this example, stating that they have discussed this problem in their group). In this case the system offers a quick test to see whether it accepts the learner's claim as valid. Negotiation of learner models can take place using a variety of methods – menu-based selection of arguments [5]; buttons to initiate dialogue moves in dialogue games [8]; natural language discussion with a chatbot [16]. In most cases, even where negotiation takes place through a graphical interface, a text version is recorded for reference during the negotiation and afterwards. This record can also be kept as further evidence for the system, in subsequent discussions of the learner model.

As stated above, in LEA's Box the learner model data comes from a variety of activities. These may be simple quizzes, intelligent educational systems, or self or peer assessments. Thus, negotiation may not always be so clearly focussed on specific

points such as a misconception as in the above example. However, the evidence used in negotiation can still be meaningful and, indeed, beneficial for both increasing the accuracy of the learner model and facilitating learner reflection. For example:

- LEARNER: My value for [matrices] should be [higher].
- SYSTEM: Your use of [OLMlets] showed [some difficulties].
- LEARNER: In [group discussion 2] I understood [well]. The [peer assessment] is [too low].
- SYSTEM: [Group discussion 2] was [5 days] ago and the [peer assessment] was [4 days ago]. You used [OLMlets] [1 day] ago. The level of [matrices] in [OLMlets] was [easy].

In this example, the system accesses the timestamp of data: in this case data from OLMlets [2]; and a peer assessment following a group discussion. It is able to explain that the first set of data was older, and also that the more recent OLMlets data was from a quite basic task. If the learner did not wish to accept the reasoning, the system could further explain that easier exercises can lead to higher scores, and that the learner was now working on more complex tasks, so old data would be less relevant. Through negotiation, as well as determining the correct representation for the learner model, the learner should come to better recognise their skills as they are required to think about the evidence provided by the OLM as well as in any justifications that they themselves give, supporting their claim. In addition, if the learner has disputed a peer assessment, the interaction will allow them to better understand that assessment, or have the opportunity to persuade the system to correct the disputed value.

Thus, the LEA's Box approach that is currently under development draws on the benefits of OLMs as meaningful visualisations of learning, as well as the benefits of negotiated learner models that can increase the accuracy of the learner model while also promoting learner reflection and other metacognitive behaviours. This is particularly useful when learners may be using disjointed applications, and when the learner model data includes data from other users. For the latter, in addition to the potential to increase the accuracy of the learner model, the process allows learner frustrations and perceived unjust assessments to be handled.

The current method of learner modelling uses a simple weighted algorithm, applying heavier weighting to more recent data, regardless of their origin [3]. However, teachers can adjust the weightings for individual activities according to the relevance of an activity for the learner model. As well as the recency of data as indicated above, the learner model negotiation will take account of these teacher weightings, and include these in its reasoning when 'defending' a representation during negotiation.

4. Summary

We have explained how benefits of negotiating learner models can be applied in today's contexts of multiple applications contributing learner data, as well as other activities which may include group interaction and peer assessment. By giving self, peer and teacher assessments the same status as automated data from various sources, such assessments can offer valuable insights to the learner's current learning state. Including this data also allows a system to better gauge the learner's viewpoint on

their understanding (through self assessments), and also take into account learning outcomes from non-computer-based or non-tracked activities (from self, peer and teacher assessment). By negotiating the learner model, users can help maintain their learner model, and through this process they should also benefit from the critical thinking required to justify their viewpoints if they disagree with any representations. In addition, learner model negotiation allows a method to verify peer assessment values, and a means to allow a learner to try to update the learner model in cases of unfairness or perceived unfairness resulting from peer contributions to their model.

Acknowledgement

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