Negotiated Learner Models for Today

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Abstract: Negotiated learner models can help improve the accuracy of a learner model as well as promote metacognition. This paper defines directions for negotiating learner models based on multiple data sources, as the range of technologies and interaction types increases.

Keywords: Open learner models, negotiated learner models, technology-rich classrooms

Introduction

Learner Models (LM) offer personalisation, and are a core part of intelligent systems [1],[2]. Open LMs (OLM) give access to the LM in a human-understandable way, e.g. skill meters [3],[4], concept maps [5],[6] and, recently, treemaps [7],[8]. The OLM therefore not only allows personalisation, but also offers itself directly to users to prompt metacognition (e.g. reflection, planning) [9]. Control over the LM may rest with learner or system, or there may be mixed control [10]. We here focus on LMs that can be negotiated. This aims for an agreed LM by allowing the same argumentation and justification moves to both negotiation parties. Likely advantages are increased LM accuracy (taking into account the user's view of their skills), while promoting reflection during negotiation [11],[12]; and can form the basis of learner assessment [13]. These are strong educational reasons for negotiated LMs, but classroom needs have developed rapidly: there are now many activities and technologies in use, e.g. e-portfolios, blogs, wikis, social networks [14]. There is a call to integrate OLMs with e-learning approaches, such as e-portfolios [15], or more broadly in e-learning with the OLM at the centre [16]. Indeed, OLMs built on a range of sources are being investigated [17],[18]. Our aim is to unite current e-learning practices with benefits of negotiated LMs.

1. Negotiated Learner Models

LMs are usually negotiated by a student and tutoring system. However, other stakeholders can be involved, and the notion of system can include a range of technologies. We consider (i) fully negotiated LMs; (ii) partially negotiated LMs; (iii) other types of LM discussion.

(i) Mr Collins aims to increase LM accuracy by user-system discussion of the LM, while also promoting learner reflection through discussion [11]. The LM has separate belief measures: system inferences about user knowledge, and the user confidence in their skills (input with responses to questions). Mr Collins uses menu-based discussion to allow users to challenge and respond to the system at any time, and it initiates discussion if there are discrepancies between its inferences and the user's stated confidence in their knowledge. This follows the notion of interaction symmetry (system and student have identical negotiation moves) [19]. These include initiating, maintaining, ending discussion; and allow each party to request explanations, challenge beliefs, justify viewpoints, amend beliefs,

accept compromise, maintain beliefs (if student and system do not agree, both inconsistent beliefs are retained). Adult users challenged Mr Collins if they disagreed with their LM, and suggested changes. STyLE-OLM [12] uses a dialogue game based model in negotiation, with the following dialogue moves (adapted from [20]): inform, inquire, challenge, disagree, justify, agree, suggest, skip. Initial findings gave additional support for the potential to promote reflection in university users. Based on the negotiation options of Mr Collins [11], CALMsystem uses a chatbot in negotiation [21]. Evaluation with 10-11 year olds showed significant improvements in self-assessment and reduction of LM discrepancies.

(ii) Close to negotiated LMs is xOLM [22]. Based on Toulmin's argumentation model [23], xOLM uses: data (actual belief); claims (summary belief - level I, II); warrants (evidence for beliefs); backings (qualitative/quantitative attributes supporting warrants). However, xOLM relies on users to initiate discussion. For example, students can challenge claims, warrants, backings; and receive justifications from xOLM. They can agree, disagree or move on (without resolution). New evidence is added to the LM, which can then be explored by the user. xOLM allows user challenge to succeed if there is unresolved disagreement [22]. In contrast, EI-OSM defers the decision to the (human) teacher if student-teacher interaction cannot resolve discrepancies using the system's evidence-based argument approach [24], also based on Toulmin. In addition to data, claims, warrants and backings, EI-OSM uses rebuttal and rebuttal data. Teachers had mixed reactions to considering assessment claims from students without evidence, but they believed these could be a useful starting point for formative dialogue [24].

Also relevant here are persuadable OLMs. The main difference between these and fully negotiated LMs are that (as with [22],[24]) models that can be persuaded do not offer each partner the same moves, or matching roles in diagnosis. A system has to agree before changes can be effected in the LM, and this occurs if a challenge comes from the student. For example, EER-Tutor has a component to allow users to challenge LM concepts [4]. A student can initiate a dialogue at any time. The system offers a question, and the LM is updated accordingly. Flexi-OLM also allows users to challenge the LM [5]. It gives evidence in the form of responses that led to its inferences, to provide a reflection resource. Students can try to persuade after seeing evidence, and similar to EER-Tutor, can demonstrate their knowledge by answering more questions.

(iii) While not negotiated, OLMlets [3] was used with Facebook for university users to discuss their LMs [25], indicating willingness to critically consider understanding in an open-ended way. This is crucial for model negotiation between humans. Another case where the LM is not negotiated is children giving self-assessments if they disagree, quantitative and text, for the teacher. This can become a focus for teacher-child discussion [26].

Research on student-system collaborative assessment found university participants acting as (human) teacher-student pairs would challenge an assessment and resolve disagreements in a manner resembling negotiated LMs [27]. This also supports the idea of student-teacher LM negotiation. Later work on negotiation between assessee (student) and assessor (system/teacher) [13] raised issues such as: assessment criteria; reasons for criteria; extent that student can challenge criteria; evidence to collect in interaction; sources of material to consult; negotiation ground rules; how to choose/communicate ground rules; extent student can influence negotiation outcome; learning during negotiated assessment [13].

2. Challenges for Negotiated Learner Modelling in Today's Classrooms

A challenge is to help teachers make effective use of information about students for classroom orchestration or offline consideration. OLMs are taking up the challenge of collecting data from multiple sources and presenting it in a meaningful way [17],[18], where the re-

sulting models can allow technologies, learners or teachers to adapt learning/teaching, with technology or face to face. Our aim is to enhance such approaches by incorporating the benefits of negotiated LMs. As identified, main themes are: identical negotiation moves (fully negotiated); evidence for LM data; objects/artifacts of discussion/for consultation; ability to challenge LM; learning during negotiation; control over negotiated LM. By definition, negotiation implies identical argument or dialogue moves and rights. However, as seen, there are also reasons to use partially negotiated LMs. We therefore include all here.

For negotiation to have meaning, there must be *evidence* to support arguments. This could be based on more complex reasoning, e.g. using Toulmin's argument structure (data, claims, warrants, backings, rebuttal, rebuttal data) [22],[24]. However, while a detailed, more formal approach, this would be less flexible in today's classrooms. Alternatively, evidence could come from work produced by a learner, system explanation of its inferences and their sources, a student claim to have completed an activity. The latter may not be acceptable to teachers in formal assessment, but it may be a beneficial focus for student-teacher discussion [24].

Much evidence will point to *objects or artifacts*, e.g. essay (with simple statistical information), teacher appraisal, quiz outcome, spreadsheet calculation showing a skill, avatar activity log, wiki, blog or discussion entries (maybe with peer appraisal). It will be necessary to provide evidence at the appropriate level of granularity. For example, if a learner *challenges* inferences from detail of an online science experiment (e.g. choice of experimentation method), the system or teacher will need to present evidence accordingly. The artifact might be an activity trace combined with inferences drawn from the trace. If the student challenges the model at a broader level (general competence in scientific experimentation), the system might initially present an overview of sources of data. Challenge is also intended to promote reflection and encourage metacognition [10]. Therefore a user may *learn* while negotiating. The LM must update accordingly, raising the issue of how updates are represented. If negotiation around data from a specific application results in learning related to that application, a narrowly focused representation could be entered. If it could also apply in other contexts, it becomes a question of how broadly to apply new learning. It is also crucial to consider which party has *control* over negotiation outcome. This may be system [4]; student [22]; separate equally valid representations for each party [11]; or teacher (in student-teacher negotiation) [24]. In the following section we offer an example.

3. Combining Negotiated Learner Modelling with Current E-Learning Approaches

The Next-TELL OLM may use various data sources: self, peer and teacher input, alongside automated data from various activities, applications, and software (e.g. Moodle quizzes, Google docs, spreadsheets, social networks, OpenSim, e-portfolios) that may provide different granularity and levels of access [18],[28]. It is an “independent OLM” [10]; there is no system teaching - the OLM gives responsibility for learning to the learner, or help for the teacher. Using independent OLMs with e-portfolios is suggested as a useful way to combine two learner-centred information sources to inform adaptive training systems [15]. This could be relevant to Next-TELL in the future, but our focus is on the reverse: multiple sources of information to the LM, in line with the aim of harnessing current practices in technology-rich classrooms, where various sources can contribute to the LM [16],[17],[18]. Negotiating the LM may be even more important in such contexts, as students can lose track of activities contributing to their LM; may not appreciate the relative weighting of activities in the LM (recency/type of data); or may not realise that so many sources contribute. The opportunity to negotiate the LM in discussion with a teacher aims to help them recognise this. This may result in agreement with the representations, or provide information to help

them form an argument. OLM visualisations and related activity data and evidence (e.g. e-portfolio contents) form the objects or artifacts of discussion. In negotiation, the teacher will need to consider assessment criteria, evidence, materials, extent of student influence over the LM, take account of learning during negotiation, and ground rules for negotiation (identified by [13]). A student challenge to the LM may occur, for instance, if they believe certain activities were not taken into account in the LM. They may use the negotiation tool (Figure 1 left), the outcome of which is sent to the teacher; or work face to face, with the teacher inputting the result of negotiation if changes to the LM are needed. If a teacher receives an argument from a student – e.g. artifact-focussed discussion is supported by a linear threaded discussion associated with a particular node (activity or competency) – they can connect to a URL given as evidence. In Figure 1 (right) this is a student claiming their ability to use mathematical information in communication (in English) by a spreadsheet calculating expenditure for a holiday. Figure 1 also shows how the teacher can add LM data (clicking on stars relating to competencies) and provide feedback in fields for strengths and suggestions for how to proceed.

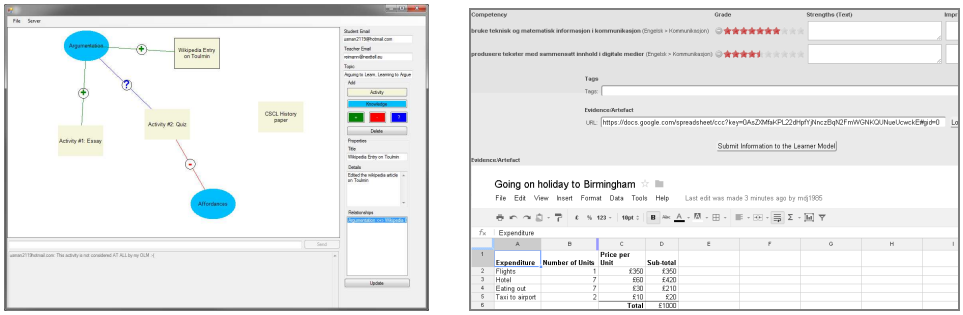

Figure 1: Next-TELL learner model negotiation example

Our example is from the Norwegian national competence goals and curriculum plan for English (see [28]), using the "communication" competence of "use of technical and mathematical information in communication". After receiving a challenge from the negotiation tool, a teacher may acknowledge the evidence (spreadsheet) in the feedback fields, but also, for example, explain: weighting of the evidence is low compared to more extensive activities (e.g. marked essay, interaction in a virtual world); the data has since been superceded; or, when aggregated with other data, this entry has relatively little influence - if, for example, a student was challenging a skill at a broader level such as communication rather than use of technical & mathematical information in communication. Alternatively, discussion may be face-to-face. The negotiation tool may still be used to help a student understand the argument/evidence relationships: for example, teachers may explain, change or add new evidence nodes (for, against, unknown). This allows users to perform the kind of discussion required for negotiated learner modelling, including the following key issues identified above: evidence, challenge and artifacts. Instead, negotiation may occur around the LM visualisations and evidence, without using the the negotiation tool. However discussion occurs, some degree of learning might take place during this process [13]. This will also need to be reflected in the LM. The current solution is for the teacher to further update the model should such learning be identified (as described with reference to Figure 1).

To address concerns that teachers may be reticent to accept claims without evidence [24], control of the LM is not with the student. The student can enter self-assessments (as above), but these do not override data unless agreed by the teacher. This teacher control is similar to the power of the system in persuadable LMs ([4],[5]), but the teacher may also initiate negotiation if they consider this beneficial (e.g. to encourage reflection). Thus, there is also some similarity to the symmetrical approach of fully negotiated LMs ([11],[12]).

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