

# Student Preferences for Editing, Persuading, and Negotiating the Open Learner Model

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**Abstract.** This paper describes a study where students were able to view an open learner model in seven formats. They were provided with tools to edit this model directly, to attempt to persuade the system to change it, or to enter into a negotiation about the model contents. Results indicate that many students are less comfortable having direct control over the content of their learner model than in situations where the system has the final say over proposed changes.

## 1 Introduction

Previous studies have suggested that offering a choice of views on the learner model may be beneficial [1, 2]. However, these studies focussed on the task of simply viewing the learner model, and did not consider how learners might prefer to interact with the model. Self [3] argues that opening the learner model provides an opportunity for the student to take some responsibility for its content, thus improving its accuracy. Several systems have implemented directly editable learner models e.g. [4, 5] while others have employed a mechanism for the learner to discuss and negotiate over the model contents e.g. [6, 7].

This paper describes a study where three modes of interaction were added to an existing multiple view open learner model. These provide the learner with varying degrees of control over the model, from editing (full learner control) to persuading (full system control). An intermediate level of control is possible in a negotiation mode. The study observed students' use of these interaction modes in conjunction with the views available, in an attempt to determine if the preferences observed for viewing the open learner model are also found in editing, persuading, and negotiating. Student opinions were sought on the usefulness of the three interaction modes.

## 2 The Flexi-OLM System

The Flexi-OLM system models a learner's understanding of basic C programming based on their answers to multiple-choice and short-answer questions. Seven presentations of the learner model are available: *hierarchy*, a logical grouping of related concepts; *lectures*, where topics are organised the same as in the related lecture course; a *concept map* showing relationships between the topics; *prerequisites*, showing possible sequences for studying topics; *index*, an alphabetical list; *ranked*,

where topics are listed in order of proficiency; and a textual *summary*. In all views (except summary) the same four-point colour scale is used to indicate the user's understanding of a topic: white for very limited understanding, pale yellow for somewhat limited, yellow/green for moderate, and bright green for excellent understanding. Red is used to indicate topics with possible misconceptions. Clicking on a topic name in the model displays more detailed information about that topic including a breakdown of understanding of specific concepts. Fig. 1 shows this breakdown viewed alongside the concept map. Fig. 2 highlights the important differences in structure of the remaining views.

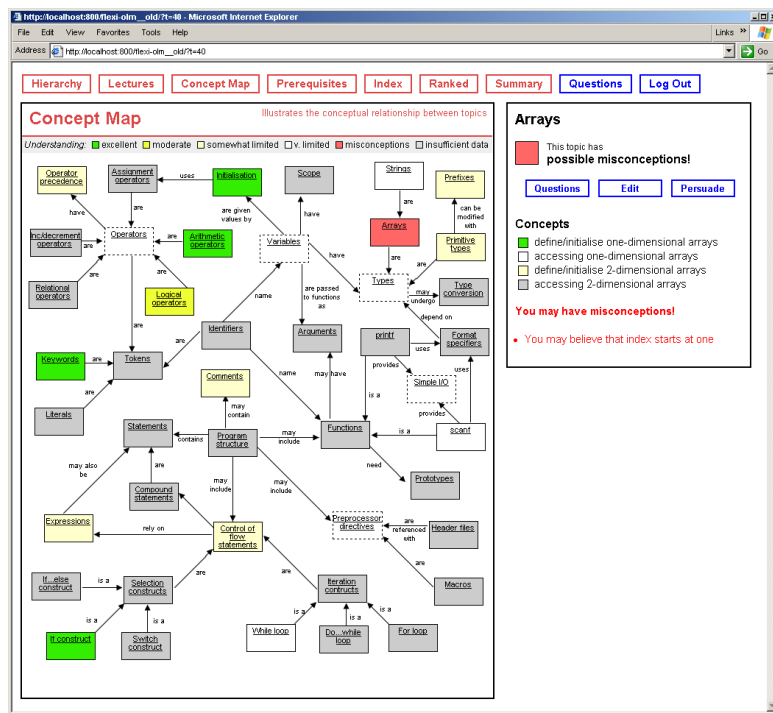


Fig. 1. Concept map view of the learner model and topic breakdown

Using the edit function (Fig. 3), learners can directly control the model of their understanding and are able to change the system's representation of their knowledge level for any concept to whatever they feel appropriate. Situations where a learner may wish to edit their model could include the following: (a) on initially accessing the system, the learner wishes to inform the system about topics they already understand (and hence do not wish to be tested on), (b) the learner suddenly grasps a concept and wants their model to reflect this without having to answer more questions, (c) the learner correctly guesses a series of answers and the system's model therefore shows a higher knowledge level than they believe they have.

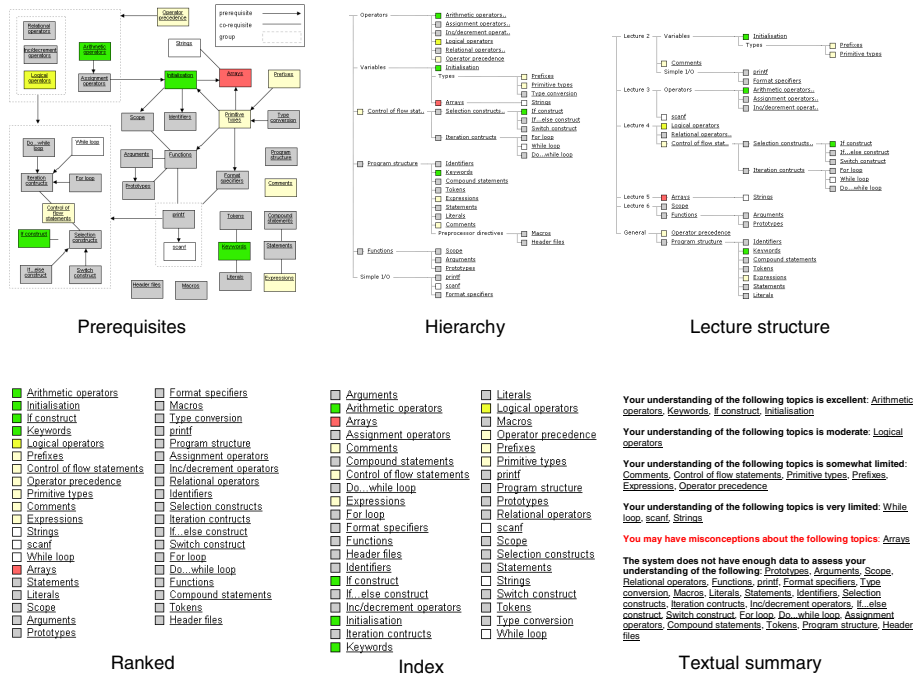


Fig. 2. The pre-requisites, hierarchy, lecture, ranked, index, and summary views

Using the persuade option (Fig. 4) allows learners to register their disagreement with the system’s assessment of their level of understanding for a topic, and propose a change to a different level. The system then explains why it believes the current level to be appropriate (by summarizing the learner’s understanding of the sub-concepts) and presents evidence supporting these beliefs (by providing samples of the learner’s previous responses that may indicate a misconception is held, for example). If the learner still wishes to proceed, they have the opportunity to ‘persuade’ the system to change their model by answering a series of test questions. Situations where a learner may use the persuade mode could include the following: (a) they believe their knowledge may be higher or lower than the system asserts, but lack the confidence to edit it unchallenged, or (b) they seek the satisfaction of proving the system wrong.

In an amended version of Flexi-OLM, a chat window was added to allow users to negotiate changes to their learner model (Fig. 5) through a ‘Wizard-of-Oz’ style interaction simulating a chatbot. Discussion was constrained by a protocol [8] based on the negotiation model of Mr Collins [6], maintaining separate belief models for system and learner, following Baker’s notion of interaction symmetry [9], ensuring that the same dialogue moves are available to both parties. Each party (a) has full control over their own beliefs, (b) can challenge the other’s belief, (c) can seek justification for the other’s belief (d) may request justification before changing their own beliefs, and (e) may ultimately decide to leave their belief unchanged. On the system’s part, justification is provided using the learner’s past responses. The system will accept the learner’s suggestion if the difference between their beliefs is one level

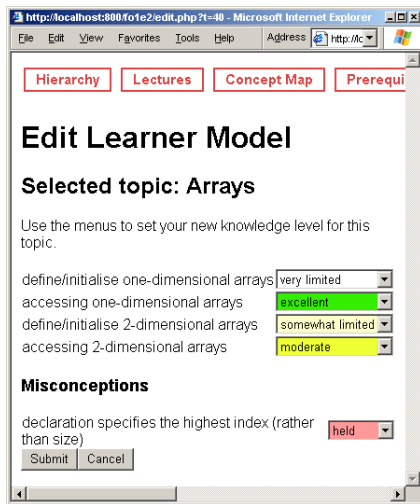


Fig. 3. Edit interface

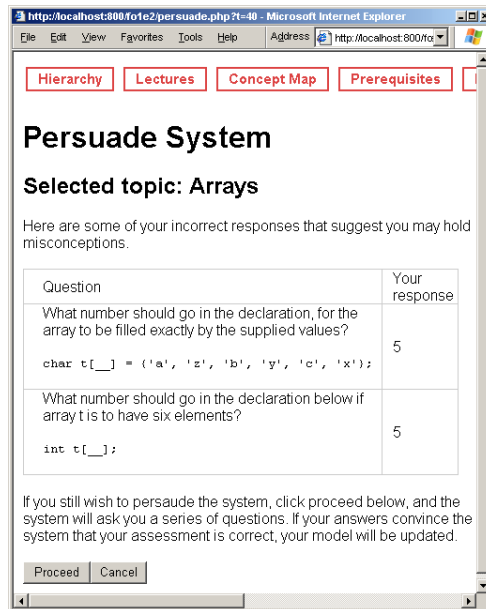


Fig. 4. Persuade interface

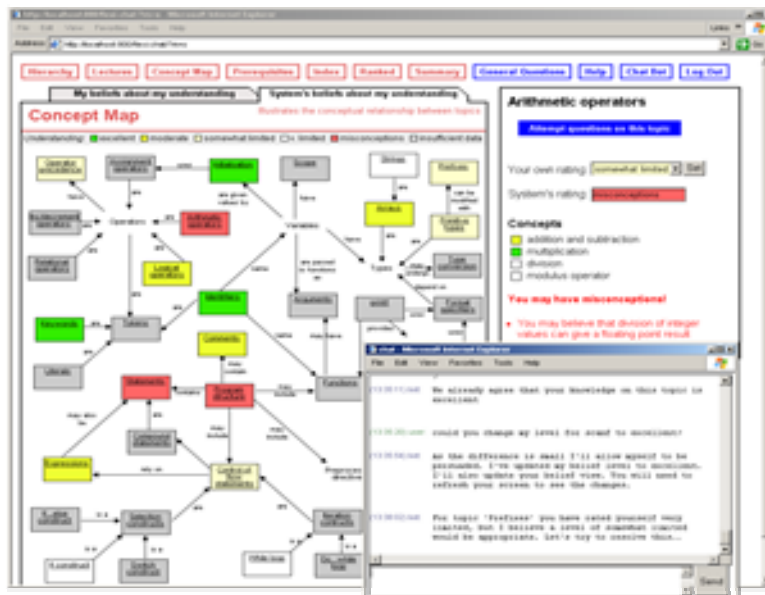


Fig. 5. Learner model and 'chatbot' window used for negotiation

(on the scale of four levels: 'very limited', 'somewhat limited', 'moderate', and 'excellent'). If the difference is two levels a compromise is offered (of changing both beliefs by one level), but if the difference is three levels the learner will be asked to

support their claim by answering questions. Tabs at the top of the page allow the learner to switch between viewing their own beliefs and the system's (Fig. 5), aiding the identification of topics where there is disagreement. The aim is to reach agreement across all topics on the student's level of understanding, although the protocol allows the system to tolerate a discrepancy of a single level per topic. If greater discrepancies are present, the system will allow a short time for the learner to propose a topic for negotiation before itself selecting the topic with the greatest discrepancy and attempting resolution by initiating a negotiation.

### 3 The Study

A study was conducted using to compare students' use of the edit, persuade, and negotiate modes of interaction.

#### 3.1 Participants, Materials, and Methods

Participants were 8 third-year undergraduate students from the department of Electronic, Electrical, and Computer Engineering at the University of Birmingham, who had all previously completed a course on C Programming. The students were introduced to Flexi-OLM (with edit and persuade functions) in a laboratory session, as part of a course on Interactive Learning Environments. They were asked to begin in 'test' mode, where the system attempts to fill the model as quickly as possible by asking questions on all topics. After building an initial model, they were told to explore the system more freely, spending around an hour viewing the model, answering questions, and using the edit and persuade functions as they wished. Immediately following this interaction students submitted a questionnaire concerning their use of the views and the edit/persuade functions.

The negotiated learner model version of Flexi-OLM was conducted as a 'Wizard-of-Oz' [10] style experiment, with human experimenters performing the role of the system for the negotiation parts – a fact not revealed to the students until afterwards (see [8] for further details). The system's initial belief model was constructed using the student's responses from the first part of the study, while the student's own model was elicited from a self-assessment completed at the start of the interaction. Participants were given a summary of the dialogue moves available in negotiation and asked to spend at least 20 minutes interacting with the system and their learner model, before completing a second questionnaire.

#### 3.2 Results

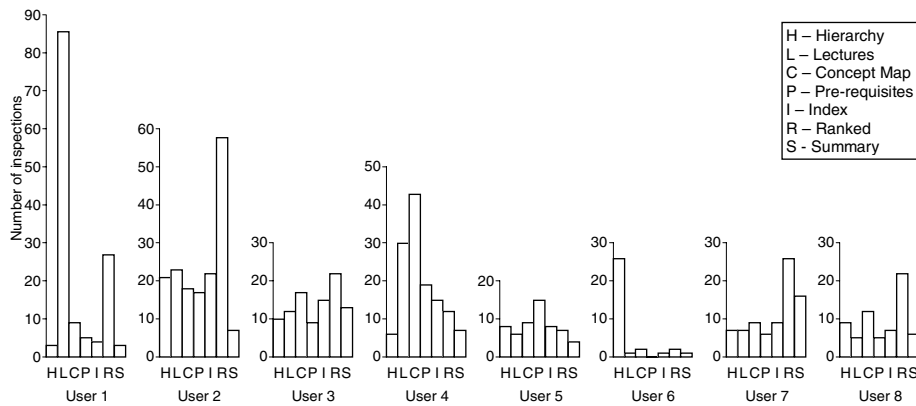
Table 1 indicates the number of edit, persuade, and negotiation 'episodes' performed by each user. An edit episode involves the user adjusting their knowledge level for one or more concepts or misconceptions within a particular topic, while a persuade episode describes any situation where the user challenges the system over the model (regardless of whether they successfully effect a change). A negotiation episode begins when either system or student propose a topic for discussion, and ends with the student's last utterance on that topic.

All users except one edited their model at least once, with the maximum number of edits performed being 6. The number of persuade episodes for each user varied between 1 and 14, and the number of negotiation episodes between 2 and 9. Two users did not attempt to initiate a negotiation, while the largest number of user-initiated discussions was 7.

**Table 1.** Number of episodes of editing, persuading, and negotiating experienced by users

User	1	2	3	4	5	6	7	8
<b>Edit</b>	6	4	4	2	2	1	1	0
<b>Persuade</b>	2	4	5	14	1	4	3	3
<b>Negotiate (user initiated)</b>	7	4	4	1	2	5	0	0
<b>Negotiate (system initiated)</b>	2	0	0	1	1	0	4	3
<b>Negotiate (total)</b>	9	4	4	2	3	5	4	3

Figure 6 indicates the number of times each user inspected each of the seven views across both parts of the experiment. Of the 8 users, only 2 (users 5 and 3) made similar use of all the views. One user (user 6) appeared to use a single view almost exclusively, while for the rest, usage was more varied. Importantly, the view receiving the most use varied from individual to individual with 5 views (all except the index and summary) being favoured at least once.



**Fig. 6.** The number of inspections of each view made by each participant

Table 2 shows the students’ responses to questionnaire statements. A five-point scale was used, with 5 indicating strong agreement and 1 indicating strong disagreement. Each participant’s responses are shown in a separate column, with the average shown in the final column. All students found viewing, persuading, and negotiating the model to be useful activities. Responses regarding editing were mixed, with 2 students finding it useful, 3 indifferent, and 2 not finding it useful. All students would be likely to persuade or negotiate in situations where they disagree with the model content, but only 2 would be likely to edit.

**Table 2.** Questionnaire statements and student responses

<b>Part A</b>										<b>avg</b>
Viewing my learner model was useful	4	5	5	4	4	5	5	5	5	4.6
Editing my learner model was useful	3	2	4	5	2	2	3	5		3.3
I would always edit my learner model if I disagreed with it	3	5	2	5	1	1	3	3		2.9
Attempting to persuade the system to change my learner model was useful	4	4	5	5	5	5	5	5		4.8
I would always challenge my learner model (try to persuade the system) if I disagreed with it	4	5	4	5	5	5	5	5		4.8
<b>Part B</b>										<b>avg</b>
Negotiating with Flexi-OLM about my learner model was useful	5	4	4	4	4	5	5	4		4.4
I would always negotiate about my learner model if I disagreed with the system.	5	5	5	5	5	5	5	5		5

**Table 3.** Selected comments from questionnaires

<b>Editing</b>
a) “Overriding what the system is telling you without proving yourself to be right seems to be missing the point of a learner model”
b) “allowed a way of cheating to improve your model”
c) “I think editing should only be decremental and not incremental as I may get some questions right by fluke, but if I know the subject matter there should be no reason why I should get the question wrong”
d) “The edit function in my opinion could be abused... Though when used sensibly saved me the bother of covering topics I know I can do”
e) “This may mean certain users will just edit their models so that they are as good as, or better than, their peers. This will not help their learning and will fool them into thinking they are doing well. ”
<b>Persuading</b>
f) “I found the persuade function useful and liked the fact it would test me before changing my knowledge level”
g) “was extremely useful in forcing me to answer further questions and realise that I do lack knowledge in that topic even if I thought I knew it well”
h) “The persuasion function definitely improved my learning as it allowed me to keep persuading until I understood the topic”
i) “The way the system allows you to persuade it to change your level of knowledge is also useful, because it helps point out what is wrong for you a little more which facilitates the user to understand where they are going wrong and derive the correct answer”
<b>Negotiating</b>
j) “Negotiation was a good feature to challenge and learn whilst gain confidence in my ability as well”
k) “Using this [negotiation] version of Flexi-OLM was far less frustrating than using the previous version... I could defend myself much more easily and quickly using chatbot”
l) “I preferred interacting with the chatbot because while I am learning I would prefer to be guided on where my weak areas are. Although that could be done using the views but sometimes you get carried away doing questions not realising you are familiar with that topic, so the chatbot pops up to remind you”
m) “Useful but could sometimes become annoying, too many interruptions”

The comments in Table 3 illustrate some of the reasons given by students for their preferences in Table 2. For editing and persuading, these also include comments from students who did not participate in the negotiation part of the study, and so whose data has otherwise not been included in this paper.

The comments about editing suggest many students view the system as an assessment tool where understanding must be demonstrated and directly editing the model subverts this process (e.g. comments a, b, and c). Despite the fact it is not possible for tutors or peers to access an individual's learner model, some students were still concerned with their peers being able to set an artificially high knowledge level (e.g. d and e). Interestingly, even students who could identify legitimate reasons for editing their own model (e.g. d) did not always believe others would be so responsible, and even suggested restricting functionality (e.g. c) to prevent abuse.

In contrast, students reacted much more positively to persuasion, where all changes to the model must be justified by answering questions, and are thus considered to have been 'earned' (e.g. comment f). Two interesting uses for persuasion are revealed. Firstly students may have insufficient confidence in their own assessment, possibly exacerbated by failed attempts to persuade the system (e.g. g), and are actually attempting to persuade *themselves* that the system's assessment is correct, rather than persuade the system to change its assessment. Secondly, are situations where students do not disagree with the system at all, but are using the persuade facility as a way to improve their understanding through practice while reviewing the evidence presented by the system (e.g. h and i).

Similarly, comments regarding negotiation were mostly positive, for example identifying it as a confidence building tool (e.g. comment j) and in one case finding it less frustrating than persuading (k). The fact that the system could initiate negotiation (in contrast to editing and persuasion which are user initiated) was viewed as useful by some users (e.g. l) and annoying by others (e.g. m).

### 3.3 Discussion

Overall, students found viewing the learner model to be useful, with all giving agreement scores of either 4 or 5 (Table 1). The interaction data (Fig. 6) supports previous findings [1, 2] that learners have preferences for views in the learner model, and the high scores in the questionnaires for usefulness of viewing the model suggest no difficulty in selecting appropriate views to use.

Only 3 of the 8 participants responded positively to the question of whether editing the model was useful, with comments suggesting many users perceive Flexi-OLM as an assessment tool and hence view editing as 'cheating'. One reason for this could be that aside from presenting an individualised learner model, Flexi-OLM's adaptivity is limited to selecting appropriate topics to question the user on (if they select 'test mode'). In contrast to a full intelligent tutoring system with teaching material and strategies, Flexi-OLM represents an open learner model in isolation, having the aim of helping learners to identify their problems so that they can work on them themselves. Hence, students may not view maintaining an accurate model as important in shaping the interaction. If the model content was viewed as more crucial to the interaction (i.e. in a system that also performed tutoring) students may have

more need for a means of making direct changes to the model (for example, to prevent the system tutoring them on a topic they already understand).

In contrast to editing, all participants agreed (6 strongly) that persuading was useful, and all agreed (3 strongly) that negotiating was useful, suggesting that students prefer situations where changes to the model must be justified. The fact that in negotiation the system will accept a very small change without justification or will offer a compromise on a moderate discrepancy could account for the small difference between the perceived usefulness of negotiating and persuading.

Persuasion and negotiation also appear to have benefits for self-assessment by making it possible for the user to prove the system wrong, and also in fostering a reflective learning cycle where the user can learn by practising questions and continually reviewing the evidence about their understanding.

Negotiation of the model illustrates a dimension of learner control beyond control of the model content – the issue of who is controlling the interaction. While editing and persuading are entirely initiated by the learner, either party can initiate negotiation, potentially allowing the system to encourage users to reflect upon their model where they would not otherwise have done so (see comment 1, Table 3). The fact that one user could justify themselves “more easily and quickly” using the ‘chatbot’ illustrates the flexibility of negotiation compared to persuasion – in negotiation a user can attempt to convince the system to change the model immediately, whereas in persuasion the system will always justify itself first.

Questionnaire responses suggest that students would be very likely to persuade or negotiate with the system if they disagreed with their model, but much less likely to edit (though two users still claimed they would always edit), a consequence of the fact that editing was considered less useful than persuading or negotiating.

## 4 Summary

Students were provided with means to influence their learner model other than simply answering test questions. Despite arguments for increased learner control brought by editable learner models, our results suggest learners were most comfortable in the situation with little direct control (i.e. persuading, where they could propose changes to the model but had to demonstrate their level of understanding before these were accepted) and relatively comfortable with a small amount of control (i.e. negotiation, where small changes could be accepted by the system without challenge), but not comfortable with full direct control (editing).

Results support previous findings [1, 2] that learners find it useful to be given a choice of how to view the learner model, and have different preferences for which view they find most useful.

Of course, there are important limitations to these results. Firstly, the sample size (8 people) means a larger scale study would be required before strong conclusions can be drawn. Secondly, the participants were relatively computer-literate, so may have less difficulty navigating the multiple-view interface and negotiating with the system than students with less computer experience. Thirdly, the study does not take account of what may happen to an individual’s preferences over a longer timescale. Although students were able to explore all the views thoroughly before editing, persuading, or

negotiating, they only had time to perform a small number of more complex interactions (for example, some students achieved only 2 or 3 negotiation episodes). Finally, the use of self-report data relies on students' abilities to know what is beneficial to them. Even though they appear to find persuading and negotiating useful, this does not necessarily mean these features actually help them learn. However, at the very least, these results suggest that further studies contrasting editing, persuading and negotiation of the learner model are worthwhile.

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