Roles for Mobile Learner Models

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Abstract

This paper discusses uses for learner models in mobile adaptive learning environments, focussing on how different learner modelling issues and attributes may be relevant in a mobile learning context. These issues are illustrated by four simple systems. More complex environments can be built according to the principles illustrated in these initial implementations.

1. Introduction

Mobile intelligent tutoring systems (ITS) combine the flexibility of individualised tutoring with the flexibility of learning in a variety of locations. However, while there is growing interest in opportunities for mobile learning on handheld computers, this is mostly not concerned with adapting an interaction to the specific needs of the individual. Ketamo offers a simple example in The Adaptive Geometry Game, which adapts polygon recognition questions as appropriate to a child's skill level, according to their accuracy and speed of response to questions [1]. This mobile system is very similar to the traditional ITS on a desktop PC.

However, interesting possibilities can arise with mobile ITSs. Many of the traditional learner model attributes remain relevant (knowledge, preferences, misconceptions, etc.), but there are also issues that do not usually apply in PC environments. For example, how may location of the user affect an interaction? How might desktop and mobile PCs be integrated to allow the user to interact with whichever device is most convenient at the time? In this paper we introduce four mobile ITSs that address such issues.

TenseITS is a mobile ITS for learners of English, focusing on the use of tense. Interactions are based on standard learner model information on knowledge, difficulties and misconceptions, enabling interactions appropriate to a learner's educational requirements; and on additional contextual information indicating the amount of available time and likely concentration and distraction levels in the learner's current location. Thus TenseITS differs from most existing approaches to context- or location-aware mobile learning because the location is not related to the content of the mobile learning materials. It also differs from most ITSs in that location-related attributes need to be considered.

We also present C-POLMILE, a system for C programming. This is a traditional ITS, modelling knowledge, problems and misconceptions, adapting the interaction accordingly. The main difference between C-POLMILE and other ITSs is that the learner model can be synchronised to a handheld computer for seamless continuation of an interaction when the learner is away from the desktop PC.

A second system that combines interactions over the desktop PC and handheld computer is MoreMaths (Mobile Revision for Maths). In contrast to C-POLMILE, in MoreMaths the interactions on the two devices are different. The main interactive maths tutoring takes place on a desktop PC, with additional individually tailored revision materials recommended for later use on the handheld device.

Each of the above systems opens the learner model to the learner: in MoreMaths and TenseITS to help the learner reflect on their understanding, and in C-POLMILE also to allow them to edit their model as the two versions of the learner model can become inconsistent if the student does not synchronise their model between interactions on the two devices. In our final system, SQL-ITS (an ITS for administration of the Microsoft SQL Server database), the learner model is also open. In addition to the student being able to view their learner model, the models may be shared amongst learners to enable them to see how their own understanding compares to that of others, and to prompt collaboration. While the models can be shared on the desktop PC, most relevant here is that they can also be synchronised to mobile devices, and shared when learners come together away from a computer lab. This combines the individual approach on a desktop PC with collaborative learning and peer tutoring in a variety of convenient locations.

The learner models in these systems are very simple, inferred mainly from answers to multiple choice questions designed to identify a learner's knowledge state. Thus the focus of this paper is not on the details of learner modelling, as there is nothing

Proceedings of the The 2nd IEEE International Workshop on Wireless and Mobile Technologies in Education (WMTE'04)
0-7695-1989-X/04 $ 20.00 © 2004 IEEE

particularly interesting in the modelling techniques themselves, but the aim is to discuss the educational potential of approaches such as those described.

2. Background

The four systems were designed based on an initial study of 17 MSc students, who had been loaned Compaq iPAQ Pocket PCs for the duration of their course. The students took part in a questionnaire study and kept logbooks of their iPAQ use over a 6 week period, recording applications used, tasks, location of use and length of time [2].

The questionnaire study showed students were keen to have a mobile adaptive learning environment. Together with the logbook results that clearly show students are already using their handheld computers in a variety of locations for a variety of course-related tasks, this suggests that systems such as those presented in this paper could be a useful resource, providing students with individualised learning opportunities at times and locations where tailored learning interactions would not normally be possible, but would nevertheless be welcomed by learners.

However, the systems are intended not only for when students are on the move. If a student is waiting for friends in the department common room, for example, expecting their lecture to finish in 20 minutes, they may decide that it is not worth going to the computer lab. Instead they could undertake a short interaction in the common room on their mobile device. This is an individualised learning opportunity that would probably otherwise have been missed.

Furthermore, the logbooks revealed that it was not only when they were on the move or had short periods of time such as in the above example, that students used their iPAQs. They even recorded using them in a computer lab where it would seem likely that a PC would be more useful! (There is no availability problem of lab PCs for these students.)

We describe the four systems below.

3. TenseITS

Conventional ITSs usually assume the user will be interacting in a single location or small set of similar places, and that they will focus on the task. Learning with a handheld computer may occur in a wider range of settings, and not always when learners are able to concentrate fully. Furthermore, they may simply wish to fill in a small amount of time while travelling or waiting for appointments, etc. Therefore, to support the mobile learner, as well as modelling the standard attributes of knowledge, misconceptions and other difficulties to determine the educational needs of the individual, TenseITS adapts the interaction according to the learner's level of concentration, likelihood of distraction or interruption, and the time they have available. When determining a suitable interaction, TenseITS will present tailored tutorials and/or individualised interactive question sessions with feedback, as appropriate to the learner’s knowledge state and these additional contextual features.

Figure 1. Providing the context attributes

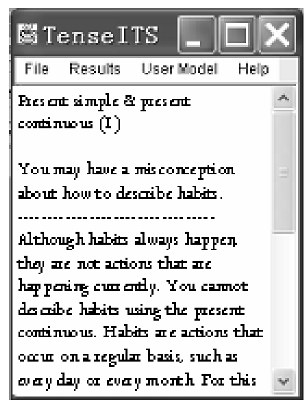

Figure 2. Feedback

Figure 1 shows the context screen at the start of an interaction. The user's default concentration and interruption settings for this location are automatically selected when the location is selected. These can be changed by the user if the usual values for that location do not apply. The time available is also selected. In this example, the learner's context is unsuitable for the introduction of a new topic because they cannot fully concentrate and are likely to be distracted. Therefore TenseITS recommends revision of the last test with only a few questions, since in addition to the inability to concentrate fully and the likelihood of interruption, the learner does not have much time. There follows a short series of multiple choice questions relating to the previous topic studied, as it is inferred from the learner model that the student could benefit from further practice on that content.

The student's answers will be used to update the learner model for the next learning session.

Feedback is supplied on the number of correct and incorrect answers and overall score, followed by feedback related to the student's knowledge, general difficulties and specific misconceptions. Figure 2 shows an example where the learner has a misconception about describing habits in English. The feedback flags this misconception, explaining the correct way to describe habitual actions from the starting point of the learner's misconception - i.e. the feedback explicitly builds upon the learner model data in order to provide explanations working from the perspective of the learner's current understanding.

4. C-POLMILE

As with TenseITS, C-POLMILE can be used in any location. However, the learner controls the type of interaction: browsing information, individualised tutoring, multiple choice questions or interacting with the learner model. The interactions on each device are identical, with the desktop PC where available, and the handheld device when on the move.

C-POLMILE models knowledge, difficulties and misconceptions, adapting the desktop PC or mobile interaction in a similar manner to standard ITSs. The main difference is that C-POLMILE requires an editable learner model to enable a learner to directly alter their model if they believe it to be incorrect. An editable learner model is particularly important in C-POLMILE because the interaction possibilities on the two devices are identical, requiring synchronisation between devices if the learner model on each is to be updated automatically. If the learner has not had the opportunity to synchronise their learner model between sessions on different devices, they need a method such as this to update it manually.

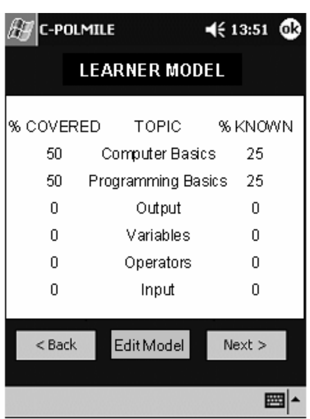

Figure 3. Textual display of the learner model overview

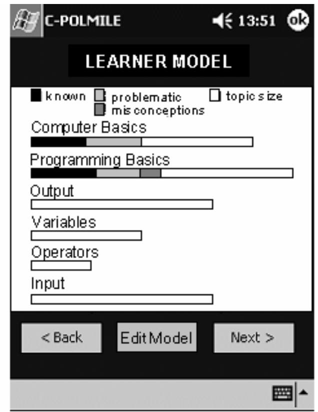

Figure 4. Graphical display of the learner model overview

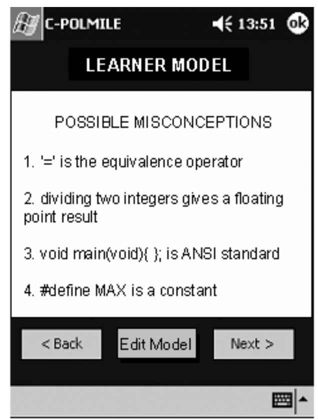

Figure 5. Misconceptions

Figure 6. Editing the learner model

C-POLMILE displays its learner model as in Figures 3-5. Skill meters are used to provide an easy overview to the learner, of their knowledge level, general difficulties and misconceptions in the various topics. Models using skill meters are not usually editable, but in C-POLMILE the user can access a screen allowing them to increase or decrease the representation of their knowledge level and proportion of the material covered. This is shown in Figure 6.

Clicking on the 'Edit Model' button on the misconceptions screen (Figure 5) allows students to click on misconceptions to delete them, if they no longer represent the learner's belief.

As well as the need to allow the learner to update their model if it no longer represents their beliefs, inspection of, and interaction with the model is intended also to have the benefit of promoting learner reflection [see 3,4].

5. MoreMaths

In common with C-POLMILE, the MoreMaths interaction takes place on both a desktop PC and handheld computer. The difference is that the main tutoring session of MoreMaths is on the desktop PC, where the learner is provided with appropriate learning materials according to their knowledge, difficulties and misconceptions. They then answer multiple choice and text entry questions to provide data to update their learner model, in order that the interaction may continue appropriately according to their needs. When the learner chooses to end their session, MoreMaths assembles individualised static review materials for synchronisation to the handheld computer, for the user to consult later, at their convenience. These revision materials include the learner model information and feedback associated with the learner model contents, similar to TenseITS, and are intended to help students not only learn the topics, but also better understand their difficulties to help them towards their learning goal. This is illustrated in Figures 7 and 8.

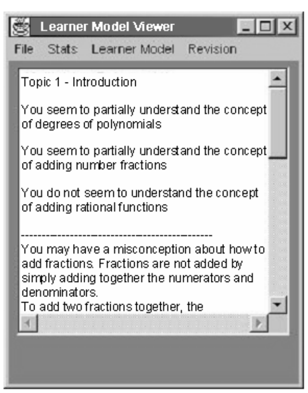

Figure 7. The learner model

The main difference between TenseITS and MoreMaths, therefore, is that TenseITS is used on the handheld computer only, and also uses contextual attributes to adapt the interaction not only to the learner's educational needs, but also as is most suitable for their current learning context. MoreMaths does not take contextual features into account, but it provides different interactions for the desktop PC and handheld computer. A traditional interactive tutorial with questions takes place on the desktop PC, where it is assumed that the learner has time to dedicate to the interaction, and can work in a focussed manner. Individualised static review materials are synchronised to the handheld device, that can be more easily used in a variety of contexts.

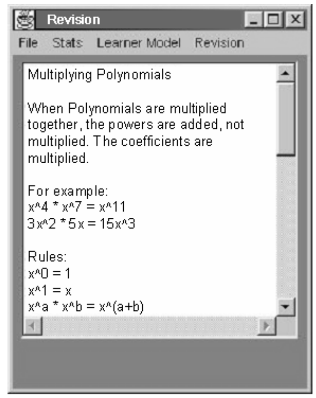

Figure 8. Revision materials

6. SQL-ITS

While some work on the educational potential of sharing student models exists in the PC context [5,6], this is not extensive. Two benefits of allowing students access to each others' learner models (assuming permission has been granted), is that learners can better judge their progress relative to their peers; and a comparison of models can help identify possible areas where students could help each other. For example, if student A is strong in topic 1, but student B is weak in topic 1; and student B is strong in topic 2, but student A is weak in topic 2, a system that allows learner models to be compared could help students to help each other.

SQL-ITS is such a system. In common with MoreMaths, the main interaction takes place on a desktop PC, with the component for the handheld computer designed for use afterwards. SQL-ITS models knowledge, problematic topics and misconceptions, adapting the interaction to these attributes. Presentation is also adapted according to the learner's study style preference, obtained through self-report. Students may obtain step-by-step explanations, undertake experiments while receiving explanations, or learn by independent reading. The learner model is updated using multiple choice questions presented after the initial learning phase.

While the learner model contains data about concepts known, difficulties and misconceptions, in contrast to the other systems described in this paper, the learners themselves see only a high level summary of this data. The aim is to raise their awareness of their areas of difficulty, including misconceptions. Students can exchange their summary learner models with their peers if they wish.

When learner models have been exchanged, students can compare their model to that of others, to gauge their relative progress and to reflect on their knowledge and understanding. Students can review their learner models together and identify areas in which they could collaborate or tutor each other. This is based on the finding of a pen and paper study that when co-present pairs are faced with a description of their respective beliefs in a domain, spontaneous peer tutoring can occur [5].

While the exchange of learner models can also take place on the desktop PC, the main aim in SQL-ITS is to allow mobile users to exchange models. Since the target MSc user group is quite cohesive, knowing each other socially as well as helping each other in their courses, and they are also regular users of handheld computers, it was hypothesised that this kind of environment could be useful in their context.

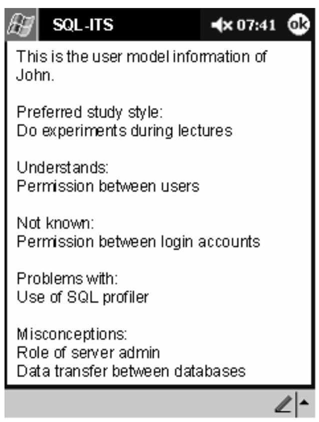

Figure 9. The contents of the mobile learner model text file

Learners synchronise their learner model after using the main tutoring system. The learner model is saved as a text file, thus does not take much space and can be carried around on the iPAQ to be used as opportunities arise. Students can exchange their models when they meet opportunistically or at pre-arranged study groups. Figure 9 shows the simple mobile learner model description. As stated above, the model content presented to the user and their peers is not detailed. The purpose of showing only the overview is to encourage discussion amongst students, to facilitate learning through conversation.

7. Summary

The four mobile learning environments presented in this paper illustrate some of the issues that can be investigated in adaptive mobile learning. One is that not only might location be relevant to the content of an interaction, but it can also affect an individual's ability to undertake focussed study, as demonstrated in TenseITS. C-POLMILE, MoreMaths and SQL-ITS show that systems might combine the use of desktop PCs and handheld computers to allow interaction on the device most convenient to the user at the time. These implementations illustrate different ways in which this may be accomplished, contrasting an ITS with an interaction that is interchangeable across devices (C-POLMILE), and two where the main interaction takes place on the desktop PC with a follow-up session on the handheld device. In MoreMaths, individualised revision materials are synchronised to the handheld computer based on the contents of the learner model created or updated during the main session; and in SQL-ITS, mobile learner models can be shared amongst users to prompt collaboration and peer tutoring at planned and opportunistic moments.

The logbook study [2] provided evidence that students will naturally use handheld computers for study at a variety of locations. The systems described in this paper demonstrate possibilities for building on this finding, allowing learners to continue their *individualised* study at times and places where tailored learning interactions would not normally be possible or convenient.

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