INTRODUCTION: HOW DO WE PROVIDE LEARNERS WITH EFFECTIVE HELP?

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The purpose of this workshop is to explore the issues concerned with the design of effective help provision within Interactive learning Environments. Learners can often recognise the solution to a problem, but cannot reproduce this solution without assistance from a more able partner/s. This requires more than the provision of context sensitive help; it requires learner sensitive help too. Effective teachers can adjust to individual learners or groups of learners and amend the challenge of a task and the amount of support they provide. Software scaffolding techniques have provided one way of implementing flexible assistance for students using interactive learning environments. Within learning systems help has been implemented in various ways. For example, Wood, Bruner and Ross's original notion of scaffolding has been shaped into the contingent teaching approach and implemented in the QUADRATIC tutor (Wood & Wood, 1996). This approach provides a series of graded help interventions that support the learner; the system always tries to reduce the amount of help being given and places much emphasis upon the importance of fading. Another approach is through emphasis upon the importance of collaboration between learners, see Guzdial, Kolodner, Hmelo, Narayanan, Carlson, Rappin, Hubscher, Turns & Newstetter, 1996 for example. Assistance is tackled through support for peer collaboration rather than graded interventions by the system. Likewise, Jackson et al. (1994) do not present assistance in the form of help interventions, but in the form of bridging between the different representations of a meaningfully situated problem.

The question of effective help provision is not just about the content of the help that a system provides it is also about how that help is made available to learners. There is much emphasis within education upon learners' metacognitive skill development that brings with it a need for system designers to explore how learners seek and use the help provided. Various recent studies have shown that learners do not always make effective use of available help (Aleven, and. Koedinger, 2000; Luckin and du Boulay, 1999; Wood and Wood, 1999, for example) This raises some interesting questions, for example:

- What kinds of help actually work across a range of different kinds of tasks and across a range of individual differences?
- How accurate are learners' insights into their own knowledge? For example, do failures to seek help indicate a failure to appreciate that help is needed? Do constant unwarranted requests for help indicate a need for reassurance & involvement with the teacher, or do they indicate a failure to realise that performance is in fact OK.
- How accurate are learner's insights into the efficacy of help, i.e. do learners' failures to seek help indicate a disbelief in the positive outcome of such a course of action? Do constant requests for help indicate an over-optimistic belief about what that help will achieve?
- How do different categories of learners vary in their help-seeking ability? For example, recent studies have indicated that: high knowledge (i.e. for that task) learners seek help more frequently than is warranted by their general ability and by their performance on the task in hand, and that low knowledge (i.e. for that task) learners fail to seek help when, in principle, help might improve their performance on the task in hand. How do we design for these differences and are there other interesting categories of learners we need to recognised?
- In the design of ILEs how should we go about metacognitive student modelling to take account of help seeking behaviour? How can we evaluate a learners' help-seeking skill level?

What kinds of tactics should be employed to react to the student (or not), to structure the assistance and to decide on the mode, emphasis and focus of the help?

- How do we make help available to learners? Should the system provide help unsolicited or should learners always have to request it? If the latter how should this availability of help be presented?
- To what extent do animated pedagogical agents solve some of these problems, or just introduce a new more fine-grained set of issues, e.g. to do with gaze and gesture (Johnson et al. 2000).

When we circulated the original Call for Papers we hoped to encourage submissions that would allow us to motivate discussion of some of these questions at the workshop. We were delighted to accept the ten papers included in these proceedings. These papers do indeed address many of these issues. The papers are diverse and interesting and will undoubtedly promote some fascinating presentations and dialogue in San Antonio. In the remainder of this foreward we present our thoughts about some of the relationships that exist between the work they describe. As is to be expected the papers to not fit neatly into subcategories. There are however areas of overlap in objective, approach or outcome. These are just some of the interesting threads that we saw; other readers will of course see other equally valid connections.

Helping learners learn to learn better

The paper by Bull, Greer, McCalla and Kettel discusses their evaluations of a voluntary resource that students taking courses in computer science can use to help each other. It is an asynchronous help forum called I-Help. They are looking to see how students can be motivated to help each other and their work addresses these five questions in particular:

Is there sufficient use to satisfy active help-seekers and less active users?
Will sufficient students offer help to make asynchronous forums a viable option as a help resource?
Will help-providers benefit, as well as help recipients?
To what extent will instructor participation affect student participation?
Will student participation levels change over time?

They suggest that Yes, there are sufficient helpers and helpees to make the resource viable, and that both helpers and helpees do benefit from their use of I-Help. Both categories gain higher marks than their non-active or non-participatory peers, though helpers gain to a greater extent than helpees. Instructor participation is more influential upon help seeking than help provision behaviour and may also be a factor in the increasing use of the system over time; with the initial contributions from instructors helping to build a critical mass of activity that is subsequently maintained. I-Help did stimulate learners to help each other, to collaborate in their learning. This issue of peer collaboration is also the focus of the work discussed by Or-Bach and Van Joolingen. Their goal is similarly to encourage peer help provision amongst Junior High school science students' modelling activities. Pairs of learners use a shared work space in which they collaborate on a task. Debugging is a major activity when modelling and the system intervenes to focus learner activity upon discussion of the contradictions within the model being constructed. This system intervention represents a contrasting approach to that adopted by Bull et al; the I-Help help forum having no knowledge of the computer science domain. However, it is interesting to note that the contributions from instructors, who DO know about the domain of computer science was influential upon the behaviour of the learners using I-Help.

Returning to the relationship that exists between providers and users or seekers of help that was explored by Bull et al; we can see an interesting link to the work of Hammerton and Luckin

who are trying to learn more about children's attitudes towards help. When and how might they be willing to look for help? What sorts of hints, clues or support do children think are helpful? When asked to provide help for a peer do they offer the sort of help they themselves would find helpful or do they adopt a different rationale? The work reported by Hammerton and Luckin describes a series of empirical studies that aimed to open up a dialogue with children about these issues in order to inform the design of matacognitive software scaffolds for a system called the Ecolab, which helps children learn about food chains and webs. The provision of metacognitive support is also explored by Lloyd whose paper is discussed a little later. The design of software scaffolding for the Ecolab both at the domain and metacognitive level has been influenced by the work of Wood (Wood and Wood, 1999 for example) as has the work reported by Masthoff. The Help agent she has implemented to assist radiologists offers help interventions, the design of which was inspired by the work of Wood, Wood and Middleton (1978). She found that the help interventions provided by the agent helped users discover and make use of system features effectively. The interventions provided by her agent were available as text and audio. This attention to the mode of the help provided to learners is central to the work of Arroyo, Beal, Wing and Woolf. They explore the representation used for the help provided by their arithmetic tutor: Animalwatch. Do concrete or symbolic hints prove most effective? This work also explores the impact of individual differences upon learners use of help and upon the effectiveness of concrete or symbolic hints. The work explores the impact of cognitive development and gender upon learners' use of help. They find that learners are sensitive to changes in the quality and nature of the help provided and that girls and boys do react differently. Self-confidence was also found to be particularly influential and the authors stress the value of attending to the emotional impact of the help provided as well as to performance indicators. Their work with Animalwatch is motivated, in particular, by the poor performance of girls with mathematical problems. Many of the authors in this workshop are similarly concerned with exploring the performance of a particular sub category of learners, Bull et al; and Aleven & Koedinger, for example, discuss the relationship between prior knowledge of a domain or cognitive ability and help seeking performance.

Of the five remaining, those by Azevedo and by Lloyd, focus on learning where the goals are set by the learners themselves and the system would be regarded as an "intelligent learning environment". The other three papers, by Martin and Mitrovic, by Timms and by Aleven and Koedinger, focus on systems which take rather greater agency in setting learning tasks, and so might be designated as "intelligent teaching systems". Both names, "intelligent learning environments" and "intelligent teaching systems", are loaded terms and tend to bring with them a certain amount of (often unhelpful) baggage about learner-centred vs teacher-centred learning. Needless to say, the environments described here, and the social and educational settings in which they operate, do not fall neatly into one or other of the caricatures of the two camps. All the system designers wish to incorporate the best of both worlds.

Azevedo sets out a theoretical position on self-regulated learning and raises a number of valuable questions about self regulated learning through hypermedia, in particular when hypermedia are used for learning about complex scientific and processes, such as the cardiovascular system. His work falls under the general question "In the design of ILEs how should we go about metacognitive student modelling to take account of help seeking behaviour?".

A particular issue of concern for Azevedo is how differences in the way that goals are set affects learner behaviour. In an experiment he compared three conditions: one where learners set their own goals, one where the goals were pre-set top-down and another where the goals were pre-set bottom-up. He found that the greatest learning gains (in terms of the sophistication of understanding achieved) occurred when students set their own goals. Of more direct interest to this workshop, was his analysis of the way that the students' planning, monitoring of their learning, strategy use, and help seeking behaviour varied between students and across experimental conditions. He found that, at least for the learner goal setting condition, rather low

use was made of "external" help seeking, and certainly much lower use than of "internal" use of strategies for repairing gaps in understanding by strategies such as re-reading.

A similar concern with self-regulated learning is demonstrated by Lloyd's work, though in her case the learning task is to make effective use of the world wide web, rather than to understand a particular scientific concept or process. She conducted a questionnaire study of sixteen year old students about their web searching. Like Azevedo she found variations in the degree of sophistication with which learners were able to monitor the effectiveness of their learning and, like Azevedo, is interested in how learners can be supported by the system in the metacognitive aspects of the learning task they are engaged in.

Martin and Mitrovic describe a tutor for the database query language SQL. The tutor uses a constraint-based method both to check the adequacy of a student's solution to a problem as well as to generate new problems which specifically address that student's perceived weaknesses. This latter capability is intriguing and gets to the heart of one aspect of the workshop's theme, i.e. setting appropriate problems. They compared different modes of giving feedback when a student submitted an incorrect answer and found that the most effective was to provide a partial solution. They note that students often asked for feedback early on in the answer generating process (and not near the end as they had expected) and so the partial solution would act as a useful general indication of the way that the solution should be framed. Timms offers an outline of a system that will use pre-test data from the student under instruction as a well as data from an appropriate cohort of other students to predict the difficulty of different parts of the learning task and so make appropriate adjustments to the problems set to a particular learner. The approach takes a strong constructivist line in that it seeks to ensure that the student traverses an appropriate sequence of educational interactions (rather than traversing an appropriate knowledge map).

In the context of the PACT Geometry Tutor, the paper by Aleven and Koedinger addresses the issue of how to strike an effective balance between system-controlled help and student-controlled help. Like Hammerton and Luckin, and Masthoff their work has been influenced by that of Wood. They point out that not all students know when they need help and that some students abuse help provision by asking for it when they don't really need it. They conducted an experiment with 15 and 16 year old students using the PACT tutor as part of their normal learning. Among many results, they found that process measures such as help-seeking were useful in predicting learning outcomes. In that respect their work is in interesting contrast to Timms, above. Timms intends to use prior measures of task difficulty to adjust which problems are set and thus the degree of help likely to be needed. Aleven and Koedinger found that by looking at help-seeking behaviour one can predict how well students will do.

These are just some of the connections we have seen between the papers included in these proceedings. All ten papers address some of the questions outlined in the call and all offer the potential for some excellent presentations. We look forward to hearing them.

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