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Learning vicariously in a distributed environment

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Abstract

The notion of *vicarious learning* is introduced and discussed in relation particularly to the role of dialogue in learning. Experience and research show that dialogue is an important component in many areas of learning, particularly in complex, conceptual domains. *How to discuss* academic material is itself a learned skill that seems to have an important foundation in observing others' learning. We focus on the nature and roles of vicarious learning with a particular emphasis on the plight of the computer-based learner. Several experimental studies are outlined, especially one presenting learners with dialogues previously elicited via "Task-Directed Discussions". We find some benefits in learning, and substantial positive changes in attitudes and discussion behaviour for students having access to vicarious learning resources, indicating that being able to observe peer dialogues can provide a useful resource for learning, both cognitively and socially.

"Young people, ... when first introduced into society, ... as standers-by, may see not only all the play, but the characters of the players and may learn more of life and of human nature in a few months than afterwards in years, when they are themselves actors upon the stage of life, and become engrossed in their own parts." Maria Edgeworth, *Helen*, 1834.

Vicarious learning

Imagine that you are a shy student in a medium-sized tutorial group. You don't like asking questions, and it's all too easy to keep quiet without anyone noticing. But there are some more voluble members of the group, and every so often one of them raises a question that relates directly to an Economics problem you have been puzzling over. As the student and tutor discuss the question, you follow the argument closely; you gradually come to see that you had misunderstood one of the main points from an earlier lecture, and now you realise how to solve your own problem. Though you have not participated in the discussion, you have directly benefited from simply observing another student's learning experience and being able to relate it to your own. This kind of learning from others' learning we call *vicarious learning*¹.

In many areas of education, vicarious learning is almost institutionalised through notions like the *master class*. In music and design, well-known teachers work with individual students in front of an audience of others, to the benefit of all. Part of what is going on here is that the students are all learning the vocabulary, the locutions, the normal topics and conventions of discussion in their particular discipline. This we see as one of the most important contributions of vicarious learning: it helps the student gain entry into the culture or community of learners and practitioners that constitutes an area of study. Direct participation by the student is of course also essential, but it occurs within an environment where observation of others can inform and

influence the nature of the participation. Experience and research have shown that dialogue is an important component in many areas of learning, particularly in complex, conceptual domains^{2,3,4}. *How to discuss* academic material is itself a learned skill that seems to have an important foundation in observing others' learning.

The fundamental assumption of vicarious learning is that students can receive benefits from exposure to discussions among their peers and between students and tutors. This is expected certainly to promote learning, but also to facilitate modelling of patterns of language in new domains. Such acquisition of “speech genres” or specialised patterns and vocabulary is an important component of learning any new domain and, it appears, one which requires exposure to language “in use” by practitioners⁵ as well as to texts and other written curriculum material. However, with increasing class sizes and the move toward more computer-based delivery, particularly in tertiary-level and distance learning courses, this component is ever-decreasing and in some danger of disappearing completely. We believe that the role of technology should be to push back the threshold imposed by these constraints by opening up new media for discourse that are not subject to the same bottlenecks as traditional methods⁶, and indeed to address problems that are already being created by initial uses of the technology itself. A particular worry for distance learning students (though increasingly also those on campus), working primarily from home or some technology resource centre, accessing learning materials often via the internet, is that they may only rarely be able to engage in direct discussion of problems with a tutor. They are also cut off from situations where they can learn vicariously from the experience of other students. Even where students are on campus, the general pressure on resources means that they are increasingly expected to work alone on computer-based materials, and have drastically reduced access to tutoring staff time.

Dialogue and the isolated learner

Here we discuss the nature and roles of vicarious learning with a particular emphasis on the plight of the computer-based learner. Consider a classic computer-based learning situation, where the student is delivered information in the form of “courseware” via the internet or a CD-ROM. We see this as just the first stage of a learning process that cycles through at least two further stages⁷. The student may be provided with activities that relate to the information that was delivered, such as example problems to solve. Sometimes, feedback on the student's performance can be provided by the courseware itself. Where we think of the initial information delivery system as *primary courseware*, this more activity-based material is *secondary courseware*. Furthermore, in the process of problem-solving, the student may naturally run into quite deep difficulties. Traditionally, the best hope here is in recourse to dialogue with a tutor, but provision of this facility to the computer-based learner is difficult and expensive. Perhaps if, as in the tutorial we imagined at the outset, the student can witness a discussion of a similar problem with another student, the underlying difficulty will be illuminated. If there are no such discussions, the student will have to contact the tutor, but then if the outcome is a useful learning experience perhaps this can be kept and re-used for future students in similar difficulties. We thus envisage the collection, organisation, and recycling of tutorial dialogues to create another layer of *tertiary courseware*. A simple example of this idea in action is illustrated in Figure 1, where the student is seen re-running a dialogue between a tutor and a previous student working on a similar problem.

In the particular context of the focus on *reflecting student needs* emphasised by this issue of *Active Learning*, we also suggest that tertiary courseware provides a mechanism supporting the incremental collection of material that specifically addresses the needs of students as they arise, in unanticipated ways, during their experience of a course. This is something that is difficult to achieve using only primary or secondary courseware. We expect that successive students will have similar or related needs, and that a body of dialogue material will evolve that is more and more likely to address the needs of the individual learner faced with some particular problem or issue. At least where the tertiary dialogue arises within a well-controlled and analysable context, e.g. provided by a secondary courseware task environment, this idea can be elaborated by envisaging mechanisms based on pattern-matching or case-based reasoning that try to find and retrieve dialogues most closely matching the present student's particular approach to a task and the point at which the difficulty arises.

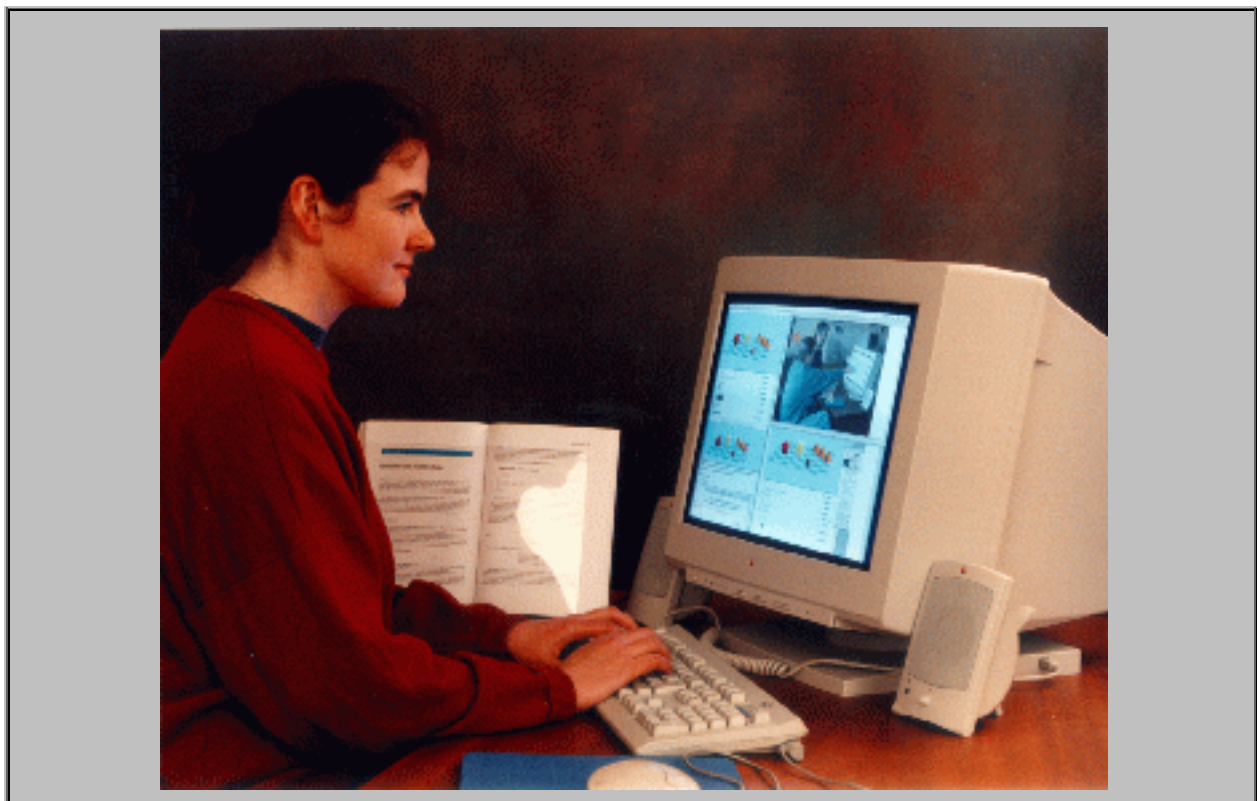


Figure 1

Obviously, we would like to know what determines the effectiveness of materials presented as tertiary courseware, in terms of conceptual development and problem solving as well as in “ways of talking” about the subject. Here we immediately find there are many gaps in our existing knowledge. An established tradition of studying “observational learning” tends to assume that it is more effective to observe *expert* performance rather than the struggles of a fellow student - is this true? It has been argued that overhearers of a dialogue will absorb less from it than a direct participant - but to what extent; and may there not even be advantages to eavesdropping? Many insist that learning derives essentially from activity and involvement - however, it's clear that observation has at least some value, so how do these interact? In our studies of vicarious learning, we have addressed some of these questions both in controlled laboratory studies and in

live courses.

In one course, students were faced with the problem of learning formal techniques for analysing English sentences. They typically found this quite difficult. There were exercises in constructing syntax-trees depicting the grammar of sentences, and other kinds of formal diagrams, and the students experienced many problems in completing these. We developed a computer-based tool to assist the students in creating and editing these diagrams - a typical piece of secondary courseware. We were now able to experiment with different kinds of tertiary material that might further support the students' task.

Using this system, we looked at the difference between expert monologue and student-tutor dialogue as learning materials. In the one case, a tutor constructed a diagram while explaining the activity for the benefit of students; this was captured as a movie of the manipulation of the computer tool, along with a recording of the tutor's commentary. In another case, a novice student constructed the diagram, with assistance from the tutor where needed - which was often. These materials were presented to the students as animated diagrams accompanied by transcripts of the recorded speech. We observed that although there was no clear difference between students given the dialogues and those given the "direct instruction" tutorial monologues, both of these produced better results than further conditions where students were given only animations of the diagrams or only "primary text" materials⁸. Moreover, content analysis of the student-tutor dialogues showed that the students in the recorded dialogue brought up problems that a tutor may not have foreseen, and they did so in ways that would seem very natural and "friendly" to later students. So it does seem that the tertiary materials aid learning.

A study in a related PhD project produced further suggestive results when students learning to solve syllogistic reasoning problems were shown videos of earlier students being taught similar problems. Here, the videos that most helped the vicarious learners were those in which the original student had more difficulty with the problem (the "strugglers"). Although the vicarious learners in fact preferred to watch the students who found the task easier (the "sailers"), they learned less from them⁹. Presumably, the strugglers were more effective than the sailers in exposing the possible difficulties in the task and eliciting valuable comments from the tutor.

Our research on vicarious learning has indicated benefits that are both *cognitive*, resulting in an increase in knowledge and understanding in the particular curriculum area, and *social*. One social effect is that exposure to peer discussion creates positive feelings of being part of a learning community. Perhaps more importantly for our goals, we also find that students rapidly begin to model the language and structure of the discussions to which they were exposed. We think that this introduction into "specialised arenas of language use" is precisely the type of result that we would want to foster, as well as promoting learning of new domain knowledge.

In a larger-scale experiment, we drew on materials from another course, a module we had taught on the use of computers in education. This kind of topic benefits from sustained discussion among the students, and we tried to encourage the use of a network-based system to promote on-line discussions that we could capture. We found, as have many researchers in the area of classroom discourse and small group interaction, that it was very difficult to get students to "break out" of an analogue of the traditional classroom situation in which a teacher asks most of the questions and structures most of the discussion, even when we followed the usual

conventions and techniques for facilitating small group discussion. Our goal was to encourage deep and critical discussion of difficult concepts, whereas often there is very little discussion at all in classroom and tutorial situations, but more of an uncritical rehearsal of answers. So in an attempt to improve participation and quality at the same time, Dineen developed a set of “Task-Directed Discussions” (TDDs) based on exercises used in Teaching of English as a Foreign Language. The purpose of these tasks is to overcome the “barriers of silence” found both in classrooms and on-line^{10,11,12,13,14}, and to allow students to discuss their emerging, nascent understanding, indeed to expose their potential *mis*understandings, in non-threatening ways. There are now a set of 11 such tasks that begin very simply and become gradually more complex¹⁵.

We found that students using the TDDs are able very quickly to have productive discussions about complex topics. Perhaps as importantly, they found the tasks engaging; but they remarked often that it “really made them think”. We videotaped over 30 hours of discussions among students, and between students and an expert, using the TDDs. From primary instructional materials and integrated clips taken from these videos, we created an architecture called the *Dissemination System* (Figure 2) that allows a multimedia database of video and audio clips, text transcriptions, and annotated graphics to be integrated with primary expository teaching material, all delivered via the Web. Using this system, an experiment was run to investigate the efficacy of vicarious learning resources in a controlled laboratory setting.

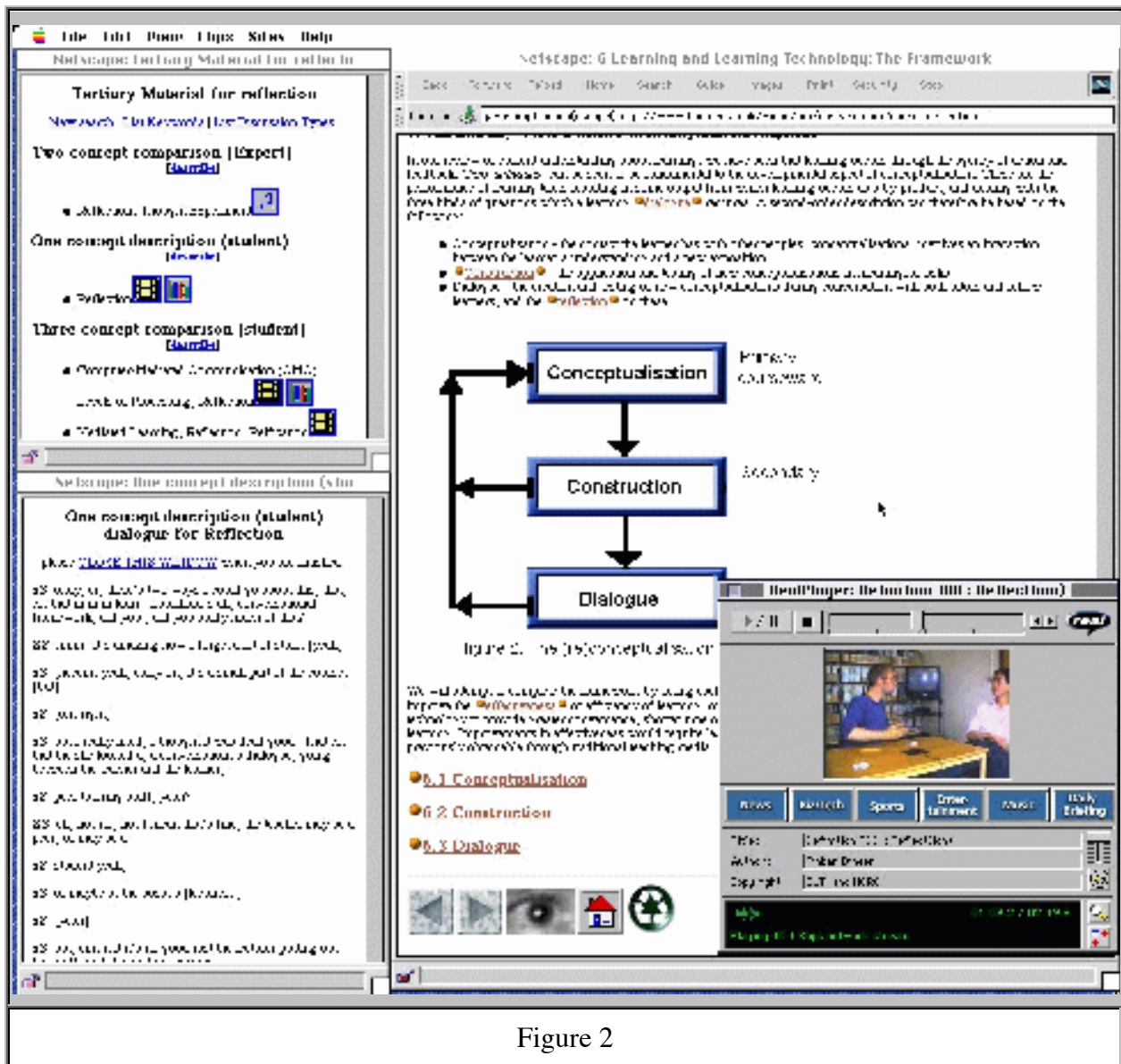


Figure 2

Experiment

The experimental system used a portion of an on-line Masters level course in Computers in Teaching and Learning that had been taught twice before. A self-contained section on Models of Learning with Technology was extracted containing approximately 14,400 words on 45 Web pages ranging from a couple of paragraphs to 1 1/2 pages in length. In addition, there were a set of "vicarious learning" resources integrated into the on-line readings. These consisted of material edited from the 30 hours of tapes generated face-to-face using the TDDs. This resulted in 108 video clips, 13 audio clips, 43 text transcriptions, and 27 audio annotated graphics that could be accessed either by clicking on highlighted keywords in the primary text or by searching on keywords or the type of discussion task.

Thirty-six students were divided into two groups based on their pretest scores on a knowledge test of the domain and on two questionnaires, one about their frequency of use of various types of media for learning and another on their views about various aspects of peer discussion as a useful source of learning, as well as matching for gender. This resulted in two groups of 18 who did not differ significantly on knowledge, stated media preferences, or attitude toward discussion. One group saw the Web-based primary learning material only (Notes group); the other saw the same material with the additional vicarious learning resources (Vicarious group). All the items on the knowledge tests could be done having read the primary material only.

The students spent 2 hours each day for two days in the lab studying the course notes and taking notes on paper, resulting in 4 hours to learn the material. Their paper notes were collected at the end of each session and returned to them at the beginning of the next session. The server stored information about each page or resource that was viewed, the amount of time spent on each, and in the case of audio and video files, how much of the clip was played. On the third day, the students had 40 minutes to review the on-line material and their written notes. They then filled in an HCI questionnaire about the system and a questionnaire about their learning experience followed by the knowledge posttest which was the same as the pretest.

On the fourth day, the students were divided into groups of either two or three (the same across groups) and participated in a 40 minute, on-line, synchronous discussion of the material using Internet Relay Chat. (Internet Relay Chat, for those who have not encountered it, is a system that provides a window for each participant into which they type messages. These messages are then displayed to the other members of the same chat session. The typed transcripts can be stored on the fileserver.) They were simply told to discuss the course content to clear up anything they did not understand. These discussions were saved for analysis. They then took a final knowledge posttest.

Results

In this paper, we are concentrating primarily on the discussion content and somewhat on the knowledge tests. Our initial analyses indicate a number of interesting differences between the groups reflected in the way they engage in discussion.

We found that students who used the vicarious learning materials scored as highly on the final posttest as those in the Notes group, with some evidence of a tendency to larger learning gains among some of the Vicarious subjects. Also, we found significant differences in the amount of discussion generated, averaging 834 words for the Notes group and 1075 words for the Vicarious group, (Mann-Whitney $U=9.0$, $p<.04$). More importantly, when scored by a blind rater for the relevance of each statement, the Vicarious students stayed on topic significantly more than the Notes group (82% vs 68%).

Looking a bit more closely at the patterns of interaction, we examined the instances where the discussion strayed from the content of the course to unrelated topics. This generally occurred either because no one could think of more questions or topics to discuss, or because no one knew the answer to the current question. We counted the number of typed utterances between the initial one that was judged to be off-topic and the one where the group was judged to be again on topic. We found that the Vicarious had significantly shorter stretches of off-topic utterances than the Notes group as judged by the rank order of number of utterances (Mann-Whitney $U = 139$,

p<.0001).

The summary table (Figure 3) shows the number of off-topic utterances for each group when recovering from one of these instances. What is striking from this pattern is that the Vicarious group has a large number of instances in which only one or two utterances are off-topic. Either a single person interjects an irrelevant comment which is ignored by the other participants or there is perhaps one acknowledging response before the group resumes discussion of the course topics. In the Notes group, while this happens occasionally, there are far more longer stretches of irrelevant banter.

Number of irrelevant utterances	<u>Frequency in Notes discussions</u>	<u>Frequency in Vicarious discussions</u>
1	2	19
2	4	14
3	5	1
4	2	1
5	2	1
7	0	2
12	2	0
13	1	0
16	1	0
18	1	0

Figure 3

What is perhaps most interesting to us is that when the students engage in discussions themselves, we find that those who had seen the vicarious resources were modeling the tasks and language used in them. For instance, in Vicarious groups, when the discussants ran out of things to say on a topic, they sometimes suggested trying one of the discussion games they had seen in the resources, as in the following excerpt:

<Discussant1> OK, perhaps we could just pick a concept and try and describe it to another person.

<Discussant2> well you can go first then

<Discussant3> accretion?

<Discussant2> adding of new knowledge to existing schema, most common form of learning

<Discussant1> Accretion is the second stage in the learning process, after structuring, and it involves adding bits of knowledge into a schema

<Discussant3> ah, I see.

The students in the Notes group, when the discussion hit a lull, tended to talk about many unrelated topics: World Cup football, television, holidays, and Elvis.

Further exploratory analysis of the discussions, using several dialogue markup and analysis methods based on sources in the literature^{11,16,17}, showed for the group exposed to tertiary materials significant increases ($p < 0.05$) in the number of occurrences of several educationally relevant discourse features. This group:

- showed more critical assessment of their own or another person's contribution to discussion;
- exhibited more use of justification — providing proof or examples to ground a statement;
- more often explicitly derived new information from known facts;
- had more tendency to signal recall or exposition of another person's argument or reasoning.

This is further valuable evidence of the power of watching dialogues to influence positively the subsequent behaviour of students in discussions. These effects are all likely to have beneficial educational consequences in the longer run. If vicarious learning is, on our current evidence, more clearly effective in promoting this “social modelling” type of learning than direct acquisition of domain knowledge, it may thus encourage valuable practices that promote learning skills across domains.

Conclusions

In the studies mentioned here, we have found some benefits in learning and substantial positive changes in attitudes and discussion behaviour for students having access to vicarious learning resources. We think that this throws up a very important challenge to some other claims about learning and raises many interesting questions. Some people have claimed that learning can only take place when students are actively and personally engaged in discussion; we believe that we have strong evidence that being able to observe peer dialogues can, on the contrary, provide a useful source for learning, both cognitively and socially. Indeed, it can be argued that such vicarious learning may at times have even more benefit than being a participant, depending on the state of the learner¹.

There are many questions that still remain, however. We do think that students need to participate in “live” discussions as well, in order both to expose their own nascent understanding and to practise the language “in use”. It may be that this should optimally take place after they have had the opportunity to “listen in”, or perhaps it should be interleaved with the vicarious experiences. Also, it may be that this type of experience is only useful when a child has reached a certain level of maturity. While we have not yet tried looking systematically at vicarious learning with secondary or primary school students, our discussions of the research with teachers

indicates that they see observation of other children as a very important source of learning and social modelling, even in very young children. There is a great deal more that could be done in looking at these questions.

We want to re-emphasise that we do not see vicarious learning as a *replacement* for direct participation, but in these days of growing numbers and dwindling resources, especially in universities, as well as increasing delivery of Internet courses for industrial training and remote students, we view vicarious learning resources as providing useful additional learning materials, affective support through increasing the feeling of sharing in a learning community, and a means of more effective immersion into the language and practice of students' chosen areas.

Future research

Our immediate plans for the future are to continue analysing the data from the current experiment and to refine our Dissemination system in order to allow others to use it more easily for their own research and teaching. We are interested in researching more particularly the effects of "overhearing" on performance and learning. There are interesting ways in which people change their discourse when they know there is an overhearer versus when there is not, but this issue has not been much researched in relation to learning. Given that we might collect educational resources opportunistically for incorporation into a Vicarious Learning system, we are interested in finding out whether dialogues produced in one way or another are more or less beneficial for learners.

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