Vicarious learning through capturing task-directed discussions

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The vicarious learner group has been developing a multimedia database system to promote and enhance the role of dialogue in learning. A specific interest, and the origin of the projects' collective name, is in the question of whether and how dialogue can be helpfully 'reused'. What benefits can students gain from dialogue as observers, not just as participants? We describe our initial attempts to generate and capture educationally effective discourse exchanges amongst and between students and tutors. Problems encountered with available CMC discourse formats led to our development of a set of Task Directed Discussions (TDDs). A medium-sized corpus of discourse exchanges was collected using the TDDs. A selection of nearly two hundred of these TDD exchanges formed the multimedia discourse database to the implemented prototype system, ***Dissemination****. Initial results from a controlled experiment and evaluation of* ***Dissemination*** *are outlined.*

The vicarious learner projects

The research programme on vicarious learning, part of which we report in this paper, has been aimed at exploring the idea that learning can be facilitated by providing learners with access to the experiences of other learners. We use Bandura's term *vicarious learning* to describe this (Bandura, 1986), and we believe it to be a paradigm that offers particular promise when seen as an innovative way of exploiting recent technical advances in multimedia and distance learning technologies. It offers the prospect of a real alternative to the building of intelligent tutors (which directly address the problem of allowing learners access to dialogue, but which have proved largely intractable in practice) or to the direct support of live dialogues (which do not offer a solution to the problem of providing 'live' tutors – unless they are between peer learners). In the research reported here our main objectives were to develop techniques to facilitate learners' access to, especially, dialogues

and discussions which have arisen when other learners were faced with similar issues or problems in understanding the material. This required us to investigate means of indexing and retrieving appropriate dialogues and build on these to create an advanced prototype system for use in educational settings.

While the role of dialogue in learning has an important place in educational and developmental theory our work has been motivated by the conviction that it has been under-emphasized in mainstream approaches to the development of learning technology. In work funded by BT prior to the present project (Mayes, 1995; Fowler and Mayes, 1997), a framework was described in which types of supporting technology could be mapped onto stages of learning. This gave a principled way of distinguishing three kinds of courseware: primary, secondary and tertiary. 'Courseware' is often interpreted to mean the representation, explanation and presentation of the subject matter content, as in a textbook. This is what we term *primary courseware*, and it encompasses many forms – text, hypertext, graphics, multimedia and most Web material. This maps onto the stage of learning called *conceptualization*. In contrast, *secondary courseware* comprises tools which learners use to operate on this primary material and the products of these operations. These can be presentation or concept-mapping tools; they might be shells in which students compose multimedia essays or problem-solving environments. Essentially secondary courseware supports learning by doing and maps onto *construction*, so called to emphasize constructivist assumptions about the need to situate learning in meaningful, task-based activity. The third sort of courseware, the focus of this project, comprises structures to support discussion between learners and tutors, and to capture these dialogues in order to render them reusable for the next group of students. We refer to this as *tertiary courseware* and it is intended to provide at least some of the benefits of small-group teaching.

The present paper looks at how the value of dialogue in learning depends on the structure of the environment in which it takes place. In particular, we consider dialogue which takes place in a CMC environment, an approach which is being adopted in many courses from primary schools through to postgraduate university courses and continuing education, often uncritically. The vicarious learner projects have been conducted by a group at the authors' institutions to study issues raised by the creation, use and support of tertiary courseware in such an environment.

Drawing on our own experience in developing Web-based CBL environments, we describe below the reasons for developing a multimedia database of discourse exchanges as a means to promote better discussions (Greeno, Benke, Engle, Lachapelle and Wiebe, 1998). The development of this multimedia system, which we call the *Dissemination* system, has been motivated by a wish to exploit technology as a means to promote patterns of discussion and enquiry that have proved difficult or problematic to initiate in traditional educational contexts (Bligh, 1986; Gibbs, 1992). We begin by looking at the vicarious learner projects' initial attempts to generate effective educational discourse and consider the various roles of the environment, the participants and the decisions of the course organizers as some of the determinants of the kind of dialogue that results. These issues underlie the efficacy of dialogue in learning, face-to-face as well as online (Newman, Webb and Cochrane, 1995).

Attempts to encourage appropriate pedagogical discourse

Many researchers have emphasized the fundamental role played by dialogue in all conceptual learning, particularly in complex, discursive domains (e.g. Voss, 1996; Laurillard, 1993). Nevertheless, in higher education at least, with increasing class sizes and the widespread development of a 'delivery' approach to learning even in conventional teaching environments, discussion between a tutor and an individual student is becoming quite rare. The danger is that the introduction of new learning technologies will be associated with a confounding reduction in dialogue, and a consequent impoverishment in the quality of understanding achieved. An important challenge for learning technology must be to maintain the benefits of dialogue in the face of pressures which work against learner-tutor contact, this being achieved by opening up new media for discourse that are not subject to the same bottlenecks in delivery and implementation as traditional methods.

The vicarious learner projects, then, propose a new type of courseware that aims to support understanding of primary course content by distilling the experience of other learners captured as discourse. Initial attempts to exploit CMC technologies led us to design a novel (at that time) Web-based learning environment involving an SGML-based integration of primary and secondary courseware, with the *HyperNews* system (LaLiberte, 1995) supporting a discussion component. *HyperNews* is a tool that manages a collection of HTML pages to provide a forum maintaining persistent discussion threads accessible through a normal Web browser such as Netscape. We taught a module on 'Computers in Teaching and Learning' twice to students who were taking a Masters' level course on Human-Computer Interaction. In the first of these (CTL1), the discussion environment was used relatively loosely, students were prompted by a few seed questions, but then were left to develop the discussion as they chose, with arbitrary but usually quite sparse contributions from the course tutors. Thus *HyperNews*, as used in CTL1, acted as a form of 'discretionary database' (Connelly and Thorn, 1991), growing and developing only under the motivation of the students themselves.

Based on feedback from the first course and suggestions in the literature on conducting online discussions (Sproull and Keisler, 1993), we made the discussions in the second running of the module (CTL2) more structured, and participation compulsory. We required tutors to post specific questions and participate more, particularly by summarizing the main points at the end of each week's discussion. These changes, which were appropriately based on the comments and observation of real users in a real setting, were not successful in enhancing the effectiveness of the discussions. Two effects were particularly striking. On the one hand, since it was now compulsory, all students participated in the discussion in CTL2, whereas in CTL1 only half of the students made any contribution, though only half of these again (i.e. a quarter of the class) on a regular basis. On the other hand, the number of questions raised in the *HyperNews* discussion in a given week in CTL1 was typically four times greater than in CTL2. A content analysis of these questions showed those generated in CTL1 to have been 'knowledge-based' questions arising from students' interests and attempts to engage more deeply in the problems underlying the course content (Scardamalia, Bereiter, Brett, Burtis, Calhoun and Smith-Lea, 1992). That is, they were engaging in discussion on the theoretical assumptions and motivations defining the knowledge domain. In contrast, students in CTL2 all participated, but in a generally much more subdued manner, restricting their questions to a

more shallow 'text-based' level (Rosenshine and Chapman, 1990). An important conclusion from these trials was the difficulty of eliciting dialogue which had any of the characteristics which we judged to be necessary for reuse. These results are discussed in further detail by Lee, Dineen and McKendree (1998).

Turning discussions into learning tasks

In response to our own experience we have developed a series of Task Directed Discussions (TDDs) which encourage students to engage in meaningful structured discussion tasks. The series of tasks gradually require students to engage in deeper thinking about the domain concepts and 'ease students in' to discussions. These TDDs are a first step both toward developing methods which will be useful for any student population and also toward testing and refining our model of educational dialogues.

In itself, each TDD is a discrete language activity with a set goal, with all discussions being based upon discursive manipulations of a common set of domain concepts. Altogether eleven Task Directed Discussions have been proposed ranging in discursive focus from single concepts to groups of concepts, with varying manipulations of these. Thus, the discussions vary in their coverage of the knowledge domain, the specificity of discussions and the types of epistemic structures that they aim to elicit and make explicit and observable to others. TDDs have been based on the lessons learnt in work on second language acquisition, where there is over thirty years of experience in using and embedding complex cognitive tasks in structured discussion groups (Skehan, 1998).

For each discussion task the idea is to focus attention on an explicit and shared set of concepts that have been derived from the primary courseware (i.e. the course content). Thus the primary courseware remains the target for each discussion task, but the form and scope of each discussion is controlled through specified manipulations of these concepts. So, each discussion form is based on a simple cognitive task and acts as an example of secondary courseware. Finally, tertiary courseware is produced as an outcome of these TDDs in the form of recorded discussions about the course content. These discussion can then be indexed into a multimedia database to complement the primary courseware. The eleven Task Directed Discussions are:

1. *Amphibolic TDD*: the goal is to examine the multiple interpretations offered by the primary courseware.
2. *Common Denominator TDD*: given a concept, name examples of its application.
3. *Comparison TDD*: describe the connection between two concepts relative to a given criterion.
4. *Defining Terms TDD*: one student attempts to describe a concept well enough for another to guess what this concept is.
5. *Depiction TDD*: explore the multiple representational structures, styles or media in which a concept or argument may be depicted (e.g. charts, text, graphs . . .).
6. *Gestalt TDD*: the explicit goal is to highlight the underlying assumptions made by another student as part of one of their explanations of a concept or argument using a given concept.
7. *Hypothetical TDD*: Encourage learners to reason to and from precepts, conjecturing to and from 'possible worlds'. Examples would be counterfactual arguments.

8. *Ranking TDD*: rank a given set of concepts in terms of level of importance along a given dimension.
9. *Reconstruct TDD*: have learners reorganize the order and propositional structure of sections of the primary courseware to explore the conceptual and functional structure implicit.
10. *Repertory Grid TDD*: select three concepts and describe in what way two are similar, but different from the other one along a common dimension (construct).
11. *Scanning TDD*: select from a designated section of the primary courseware a specified number of factors that are the most relevant examples of a given criterion.

TDDs have a number of goals, but foremost is the presumption that through taking part in them learners are implicitly helped in structuring their understanding and developing their knowledge, i.e. that learners are helped in developing their '*epistemic fluency*' (Morrison and Collins, 1995).

As a means to exploring such issues relating to multimedia indexing and modality presentation of pedagogical discourse we have developed and implemented an indexed multimedia database of these TDDs in the *Dissemination* tutoring system. A logical representation of the interface structure of *Dissemination* can be seen in Figure 1, while an example of the actual system is shown in Figure 2.

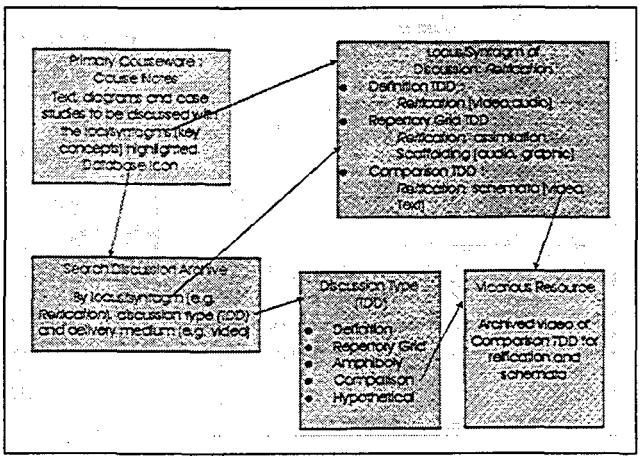

Figure 1: The ***Dissemination*** *tutoring system*

Dissemination: an indexed multimedia database of tertiary courseware

The experimental system used a portion of the CTL course material. A self-contained section on *Models of Learning with Technology* was extracted containing approximately 14,400 words on 45 Web pages ranging from a few paragraphs to a page and a half in length. In addition, a set of tertiary resources was integrated into the online readings. These consisted of material edited from the over 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.

Using *Dissemination* a study was undertaken in which 37 undergraduate subjects were required to undergo a 10-hour learning experiment. The subjects' goal was to learn and understand enough of the primary courseware ('The Role of Computers in Teaching and Learning', as in the CTL 1 and 2 courses) to achieve 70 per cent on a post-test about it (the subjects were given a financial reward for achieving this score). Subjects were assigned to one of two conditions: those who would have access only to the primary courseware, and those who would have additional access to the *Dissemination* database of TDD-derived discussions. There was no requirement on the subjects in the latter condition actually to use this tertiary courseware. The assumption was that subjects would only attempt to retrieve those examples of multimedia discourse from the database that could help them in the interpretation and understanding of the course content. In fact, subjects' own stated comments confirmed that they only made use of this material when they found it useful to do so.

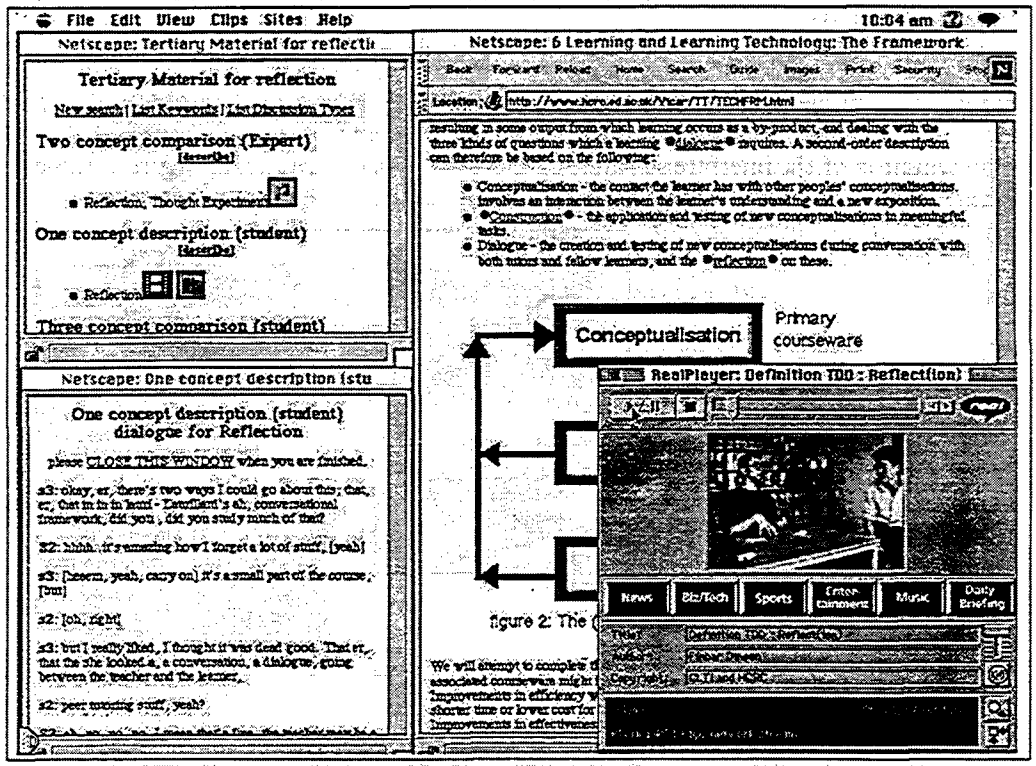

Figure 2: A screenshot of the ***Dissemination*** *tutoring system, showing the primary courseware (centre), the indexed database of TDDs for the concept 'reflection' (top left) and tertiary courseware presented as a text transcript (bottom left) and digitized video clip (bottom right).*

Each media clip entered in the system could be retrieved along three orthogonal dimensions:

1. The concept or focus topic of the TDD.
2. The form of the discourse as determined by the discourse goal specified in the TDD.
3. The medium of discourse. This is the dimension along which the discourse is captured and entered into the database (video, audio, text, graphic).

The relationship of the primary courseware to the tertiary courseware can be seen in Figure 1. In studying the course notes the learner can access *Dissemination* through an indexed set of key concepts highlighted directly (top left), or they can access an archived TDD indirectly through a search of the database (bottom left). For each key concept the learner is presented with the indexed set of all TDDs for that key concept in various media (top right). In selecting one of these along the three orthogonal dimensions the learner is shown the desired piece of tertiary courseware (bottom right).

Tertiary courseware as a vicarious learning resource

The results from the experiment are extremely rich in data, providing information on the cognitive, affective, linguistic and behavioural impact of the use of tertiary material. We have also conducted a series of structured interviews using repertory grid techniques on the RepGrid II programme (Gaines and Shaw, 1993). In addition, we are analysing the computer logs to look at the media access patterns in relation to the content of the tertiary and primary courseware. Some preliminary data that is of interest shows that there are patterns of preference and individual differences in subjects' retrieval strategies, and that these preferences for tertiary courseware develop over time.

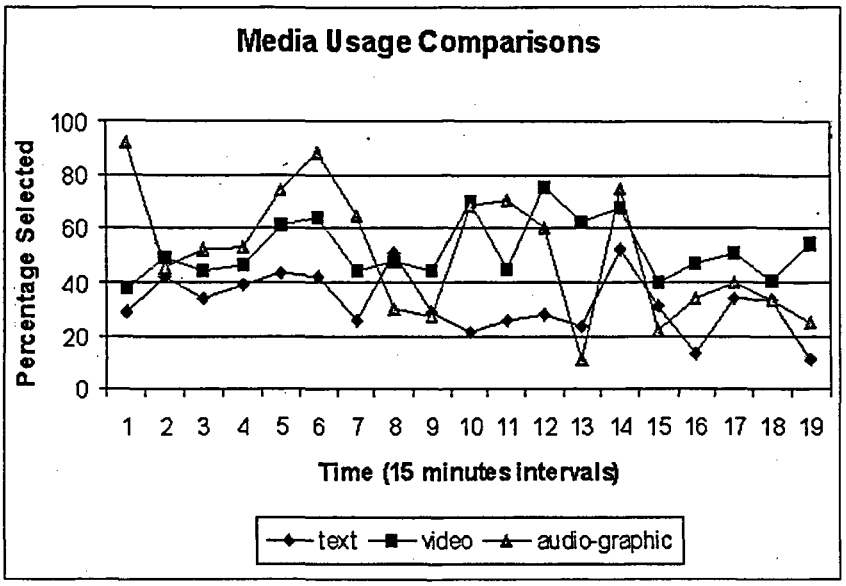

Figure 3: Graph of comparative mean rates of media use for each quarter hour.

The pattern of media use during the course of the experiment can be seen in Figure 3. There are a number of surprising patterns suggested by this data. The audio-graphic medium is clearly the preferred medium of retrieval for the tertiary courseware. In addition, it was not clear why the textual medium was used at all, as these were verbatim transcriptions of the conversants' speech (hums and stutters included). One explanation may be to understand these results in terms of the 'grounding' of the discourse available in each medium (Clark and Brennan, 1993). Yet the concept of communicational grounding does not adequately explain why subjects would access the same data in different media or would show a preference for one medium at one time and another later. This point is clearly highlighted

when one looks at the data on individual differences. For each individual there were marked patterns of preference for one medium over another, though these preferences often changed over time. Additionally, the subjects varied greatly in the volume of material browsed through compared with the number of clips they viewed or read in their entirety.

These data on the mean number of clips viewed in their entirety also pose a problem to be explained. Over the course of a single session individuals were less likely to listen to or watch a clip in its entirety, the decline being gradual from a mean of 2 per quarter hour to less than 1, with this pattern being repeated during each session. It may be that this is an indication of subjects' improvement in their ability to retrieve the information or that their growing understanding of the course notes allowed them to confirm their working hypotheses more quickly. As the subjects' understanding of the material grows, do they simply get better at retrieving the information they need, or do they need to retrieve less information?

In general, preliminary results of the *Dissemination* experiment seem complex. There is no overall effect of whether an individual learner had access to the tertiary material on the level of understanding achieved. However, this turns out to be because there are very large individual differences in the way the system is used, and in the learning strategies employed. When we look at individual learners we find clear evidence for a 'vicarious learning' effect. Subjects who have chosen to spend most time observing effective discussions subsequently structure their own free discussions of the course materials in ways that resemble what they have observed. Moreover, these subjects then show higher learning gains. It is also the case that subjects who had access to tertiary materials are significantly more likely to judge the system as representing an important learning resource, and as providing an 'enjoyable' learning experience. Interestingly, subjects who did not have access to the tertiary material rate the content as more 'correct'.

Overall, the most interesting result is that when the students engage in discussions themselves, we find that those who had seen the vicarious resources have been modelling the tasks and language used in them. For instance, in the groups who had access to tertiary courseware, when the discussants ran out of things to say on a topic, they often suggested trying one of the discussion games they had seen in the resources. These subjects also were significantly faster in returning to an 'on-topic' discussion.

As a post-test, subjects participated in a 40-minute, online, synchronous discussion of the experimental course material, using Internet Relay Chat. They were simply told to discuss the course content to clear up anything they did not understand. These discussions were saved for analysis. Exploratory analysis of the discussions, using several dialogue mark-up and analysis methods based on sources in the literature (Newman, Webb and Cochrane, 1995; Henri, 1991; Pilkington, 1996), was undertaken. It showed for the group that were allowed access 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 a tendency to signal recall or exposition of another person's argument or reasoning.

It was also noted that there were significant differences in the amount of discussion generated, averaging 1,075 words for the group with access to tertiary materials and 834 words for the others. When scored by a blind rater for the relevance of each statement, the tertiary group stayed on topic significantly more than the others (82 per cent against 68 per cent). We have here valuable evidence of the power that watching dialogues can have to influence positively the subsequent behaviour of students in discussions. This influence is likely to have beneficial educational consequences in the longer run, if the dialogues watched are well selected.

Conclusion

In striving to exploit and fully understand the nature and interaction between different courseware media, the 'Groundhog Day' model (Mayes, 1995) has provided a strong focus, proposing the exploitation of a networked multimedia database of student discussions. In view of the importance of such learning opportunities in traditional educational media (Bransford, Franks, Vye and Sherwood, 1989; Graddol, 1989), it has been important in our work to overcome the technical, psychological and educational difficulties in developing such a resource for learners in a CMC environment. Through our early work on promoting discourse we quickly identified the strategy of developing a set of Task Directed Discussions that would guide students in their interactions with the primary courseware and with each other. Having produced a corpus of such discussion tasks (some thirty hours) we implemented these as part of a structured online database of tertiary courseware for other learners to exploit.

The experiment conducted using the discourse database has produced interesting and promising initial results. Using the information from this experiment, and continuing work in developing the multimedia database to exploit the emerging SMIL standard (Synchronized Multimedia Integration Language) for integrated multimedia frameworks, we hope to implement the full tertiary courseware corpus. As part of this effort, we are currently subjecting transcripts of the database corpus to a range of linguistic measures, for both content and discourse analysis (Gunawardena, Lowe and Anderson, 1998). Such an analysis will be used to develop further the logical database structure of *Dissemination* for exploitation by researchers interested in the form and properties of pedagogical discourse and CMC environments.

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