

Exploring Student Interactions in Collaborative World Wide Web Learning Environments

Dr Ron Oliver
Edith Cowan University,
Western Australia.
r.oliver@cowan.edu.au

Dr Arshad Omari,
Edith Cowan University,
a.omari@cowan.edu.au

Ms Jan Herrington,
Edith Cowan University,
j.herrington@cowan.edu.au

Abstract: This paper describes a study in which a WWW learning environment was created using socio-constructivist instructional design principles. A qualitative research method was used to investigate the learning behaviours of classroom-based students in this instructional setting. In particular the study sought to investigate collaborative learner behaviours in settings where the instructional materials involved open-ended investigations and learner support by means of a printed guide. Observations of student behaviours provided little to confirm our contentions that such environments will create an instructional setting which encourages cooperation, reflection and articulation among students.

Introduction

There is growing interest in higher education about the use of the World Wide Web (WWW) as a learning tool. The WWW enables the development of powerful information sources to support learning and facilitates student-centred instruction [Becker & Dwyer 1994]. It supports and encourages exploration and inquiry, behaviours that are frequently associated with enhanced learning outcomes. However providing students with access to such meaningful content does not always guarantee learning. Contemporary learning theories indicate that learning is achieved through a process of knowledge construction [eg. Reeves 1993]. When a learner is confronted with new knowledge, the learner's intentions, previous experiences, and metacognitive strategies are all essential elements in determining what becomes of the knowledge. The effectiveness in any learning environment is based upon the types and levels of cognitive and metacognitive activity engendered in the learners. It is now widely accepted that learning is enhanced in instructional settings where students are engaged in processing personally relevant content and are reflective during the learning process [Jonassen 1994]. The use of collaborative learning environments seems a natural way to create such settings. This paper describes a study which was conducted to investigate the potential of a collaborative WWW-based learning environment.

Learning Through the WWW

There are a number of learning theories which can be used to describe the nature of learning in WWW and other multimedia environments. In our previous research we have been guided successfully by the theories of situated learning [Brown, Collins & Duguid 1989], social-cognition [Vygotsky 1978] and conversation [Laurillard 1995]. Such theories apply and extend information processing and constructivist learning ideas in ways which are well suited and potentially very powerful in higher education learning environments. Interest in social-cognitive theories and in social-constructivism has been fuelled in part by a growing awareness of weaknesses in information processing and constructivist approaches to describing learning [Prawat & Floden 1994]. Talk and discourse have long been seen as critical components of the learning process. [Vygotsky 1978] argues that learning is frequently achieved through interactions supported by talk and that language and talk are frequently associated with the development of higher order learning. Higher-order learning is achieved when students are confronted by tasks which lead them into cognitive conflict and resolution. Dialogue and discourse

enables and encourages this form of cognitive activity by providing a context and means for explaining, justifying and acquiring reasoning skills.

The learning value of language and discourse is acknowledged as one of the main reasons for the popularity and instructional effectiveness of collaborative learning environments. Collaborative learning is consistently used by teachers in elementary and secondary schools and continually returns significant achievement gains. These gains are usually attributed to the complementary effects of motivational and cognitive factors. The motivating factors encourage students to work towards common goals in cohesive groups where the interests and achievements of all learners are important. The cognitive gains are derived from developmental perspectives associated with children's social interactions, and resulting cognitive restructuring and elaboration brought about by the discourse and dialogue [Damon 1984]. Currently much of the teaching and learning in higher education associated with computer-based delivery is planned for individuals learning independently with computers. There appear many advantages to be gained from a move to more collaborative and cooperative learning environments.

[Slavin 1996] describes a number of strategies which have been found to enhance and encourage cooperation and collaboration in small group settings. Some of the strategies described include: developing investigative and controversial tasks without single answers to encourage articulation, discussion, and debate among learners; creating group goals for learning tasks which promote collaboration and individual accountability; and providing strategies and support to promote and aid interactions between learners. [Pilkington & Parker-Jones 1996] suggest the need in collaborative environments for pairing students with symmetrical roles to encourage them to argue and to prompt reasoning. [Palincsar & Brown 1984] describe the valuable role of tutor scaffolding to help develop dialogue strategies, and the consequent withdrawal leaving learners to generate their own discourse.

There are many forms of supports for collaborative learning although in higher education, some appear to hold stronger prospects than others. Adult learners tend to show high levels of self regulation and self-motivation in their approach to learning. In group situations, the better supports appear to those which provide a context and method for collaboration. In this project we chose to investigate the potential of the use of investigative activities and scaffolding devices as instructional supports for collaborative WWW learning. Our intention was to examine the ways in which WWW materials with open-ended inquiry based activities and support materials supported and encouraged collaborative activities, and to examine the forms of interaction and collaboration that resulted to see if these attributes influenced students' levels of cognitive processing and engagement.

Methodology

We chose a module from a local course, Multimedia Networking and Communications, for this study. A lesson was planned for a component of the course where use of the WWW as an instructional tool would be most appropriate. A WWW-based document, *Designing Home Pages*, was developed which was intended to assist students to develop a knowledge and understanding of the use and design of home pages. We created a WWW-based instructional episode that incorporated the lesson content supported by a number of open-ended and inquiry-based activities. The document comprised four chapters, each of which contained a textual description of the topic, links to relevant sites, a learning activity and a series of quiz questions. Each chapter of the document contained approximately 500 -750 words of text, 20-30 images of sample home page designs and elements, and 15-20 links to relevant WWW documents and sites.

This study was part of a larger research project research conducted among 58 university students. The component involved six students, working in three pairs across three different laboratory sessions. The students completed their learning activity on a computer with special data gathering devices attached. A small camera above the computer was used to gain an audio and video record of student interactions and this image was recorded as a window on a larger image of the display from their computer. These images provided a video recording which enabled us to see how students were behaving, to listen to what they were saying and to view the screen images with which they were working. Transcriptions were made of the discussion and exchanges between the students in each of the three groups. The interactions and exchanges between the students were tabulated and classified.

In our previous studies of learner interactions in telecommunication supported learning environments [Oliver & McLoughlin in press], we have used a set of 4 dimensions developed from [Henri 1992], namely social, procedural, expository and cognitive. More recently [Pilkington & Parker-Jones 1996] describe the DISCOUNT analysis scheme for analysing learner dialogue in collaborative environments with 5 dimensions to record the

purpose and forms of learner dialogue. While these dimensions are able to provide more detail of the purpose of interactions than those we have used previously, we chose to remain with our more general content analysis as a means to explore the general nature of student interactions in the planned environment. Our intention in this initial study was to determine the capacity of the chosen interventions to promote dialogue and discourse through collaborative learning. Our investigation sought to establish the forms of dialogue that resulted to determine if students' levels of cognitive activity and engagement were influenced. The dimensions used in this study are explained in [Tab. 1].

Type of Interaction	Description	Example
social	students discussing elements of a social nature and not directly associated with the lesson	S1: What course are you studying? S2: Multimedia and communications. S1: Does that mean you know my friend John?
procedural	students discussing matters relating to procedures and steps associated with the learning materials and WWW browser	S1: What do we need to do here? S2: I think we should go to the first screen and read the instructions. S1: Okay, I think you click here to do that.
expository	exchanges where facts and knowledge are passed with little further elaboration or development through discussion, articulation of information	S1: The screen design here is quite good . S2: I like the colour and the images. S1: The text is well laid out and easy to read. S2: The format is a bit wide.
cognitive	students' discussion leads to knowledge development and involve exchanges which demonstrate critical thinking and reflection	S1: Is this Home Page better than the previous ? S2: It's much clearer and more spacious. S1: I think the space makes the page less cluttered and the picture is less busy. S2: The space also make the links more apparent.

Table 1: A framework for describing interactions in collaborative learning environments

Outcomes

Group 1: Chris and Kate

This pair of students comprised both an experienced and inexperienced WWW user. The pair used the printed guide which provided instructions and directions in how the WWW document should be used. Initially a large number of procedural interactions were observed as the pair decided the format and scope of the task they had been set and explored the WWW environment. The more experienced user, Chris, assumed control of the mouse and maintained this for the whole of the session. Kate had had some experience with the WWW and appeared quite comfortable with the navigation and linking processes employed by her partner.

As the pair settled into the exercise, they adopted a style of displaying the screen information and each reading it quietly to themselves. This left many periods in the observation where no discussion or exchange was taking place. While other students often used such opportunities to discuss and articulate the information, this pair displayed a tendency to work independently and maintained this throughout the session. Chris would wait until Kate had appeared to have finished reading before moving to link to other pages and sites. There was rarely any discussion about which site would be chosen, Kate appeared content to let Chris choose. When pages appeared, Chris would often make a comment, for example, " nice graphics" and "I wonder what this means?". Mostly Kate would say nothing and Chris would choose another site and browse again. There were many examples of expository interactions evident in these stages that involved very short and abrupt information exchanges.

The printed guide contained a copy of the activities from the WWW document and provided space for written responses. It was intended that the students would read the textual information in each WWW chapter and attempt the activity once they had developed some understanding of the current chapter. This pair of students

tended to commence the activity as soon as they moved to each new chapter. Once again, this was done independently and there were several minutes of silence as the pair made their own notes. On several occasions, Chris commented aloud as he wrote things down and Kate concurred, but the discussion rarely developed further. This limited form of collaboration gave rise to a large number of very short expository interactions, the majority of which were initiated by Chris. In many instances Kate's contribution was agreement with no further elaboration. This form of communication limited the scope for cognitive interactions.

The last chapter in the document provided links to Home Pages of movie companies and when these sites appeared, the conversation became more discursive. Both students were interested in movies and immediately began discussing aspects of the movies that were displayed on the screen. These interactions were clearly social in nature and bore little relevance to the design aspects which were meant to be leading the conversation. [Tab. 2] shows the number of the different types of interactions observed between these students. The table shows a relatively small number of interactions in the 80 minute session and the absence of any cognitive interactions.

Type of interaction	Frequency	Relative Times
social	5	10%
procedural	15	38%
expository	31	52%
cognitive	0	0

Table 2: Interactions observed between Kate and Chris

The lack of cognitive interactions among these students was unexpected. While there appeared to be many opportunities in the learning materials for the students to reflect on issues and to discuss ideas and findings, they did none of this. The pair were clearly mismatched for this type of learning activity. At the same time, it appeared that the form of the printed guide also acted as an impediment to the collaborative activity. In following the guide, both students made their own meaning of the content that was presented and created independent accounts in their notes. The guide did not specifically encourage students to work collaboratively and in this instance, they chose not to. In providing a focus for student learning, the guide encouraged the students to follow the lesson content in a structured sequence and this limited the level of cooperation and collaboration that was observed. It is likely that had the guide carried less explicit instructions, higher levels of collaboration may have occurred.

Group 2: Raelene and Alan

This group also comprised a novice and experienced WWW user. This pair worked without the printed guide and followed their own path through the WWW pages. In the first stages of the session, there were a number of procedural interactions caused by Alan explaining different features of the browser and the pages they were downloading. Raelene was content to let her partner take the lead in deciding which links to take and when to proceed. There was a number of expository interactions as Raelene inquired further from Alan about the sites they were visiting and the content of the pages displayed. The lack of direction, from the printed guide, for example, encouraged collaborative interactions by virtue of the need for the students to agree on a learning strategy. This pair spent considerable time on the first two chapters but there was little evidence of any purpose or focus in their activity. Alan concentrated on the textual components of the chapters and followed the links that were provided going from one to the next with no apparent aim in mind. During this browsing, there were many expository interactions and few cognitive interactions. The pair viewed the pages that appeared and commented to each other on different aspects of the pages.

The pair attempted none of the activities but spent considerable time working through the quiz questions. The use of a printed guide may have ensured that the activities were attempted and could have led to the students' attention to more meaningful information and content. It was in reading and answering the quiz questions that most of the cognitive interactions occurred. The pair discussed the solutions to the questions and often built on each other's responses. The open-ended nature of many of the questions encouraged this reflection and critical thinking and the contributions of each partner often led to creative and joint solutions being developed. The nature of the discussion and exchanges between these two students tended to change as the lesson progressed. There were many interactions of a procedural nature at the start as Alan explained features to Raelene. The level of procedural interactions may have been different had Raelene had more WWW experience.

Type of interaction	Frequency	Relative Time
social	2	2%
procedural	32	32%
expository	28	41%
cognitive	13	25%

Table 3: Interactions observed between Alan and Raelene

[Tab. 3] shows the relative numbers of interactions observed among these students and the relative proportion of time of each. Both the design of the learning materials and the nature of the learning environment had led us to expect that there would have been a higher level of cognitive interactions than which actually occurred. Factors which appeared to limit the number of such interactions in this instance included the pairing of a novice and experienced user, the high level of browsing, students' choice not to undertake the activities and the failure of the students to establish an appropriate pace to cover the contents of the WWW document in the given time.

Group 3 Danni and Vicki

The third pair of students were friends. This pair also did not have the printed guide and were free to use the materials in their own way. Observation of their behaviours clearly indicated the value of cooperating partners. The pair chatted freely throughout the lesson and shared the *driving* equally. The high levels of cooperation saw a large number of short procedural interactions interspersed throughout the session as each indicated the next step that might be taken and waited for any dissenting or alternative suggestion. In most instances, a statement of the form, "let's go here" and a pointing action to a link on the screen led to that action being taken. Often the student without the mouse made the suggestion as to the next site to visit or link to make, and the other effected the action. In this group, the student with the mouse did not lead but rather acted as the agent who carried out the next step according to her own or the other partner's wishes. The mouse was swapped frequently. Both students interacted freely and large numbers of exchanges were recorded [Tab. 4]. While there were many procedural interactions, the brevity of the exchanges reduced the relative time of these. At the same time, there were few cognitive interactions overall but the level of discussion involved for each saw an appreciable amount of time in the session spent in this form of interaction.

Type of interaction	Frequency	Relative Times
social	1	1%
procedural	34	23%
expository	45	60%
cognitive	6	16%

Table 4: Interactions observed between Danni and Vicki

This pair followed the WWW document sequentially and attended to each component in turn. As the students worked through each activity, there was a large amount of discussion and articulation of the content that was being presented and a considerable amount of important information was discovered and gleaned by the students in this way. The textual information contained in the body of each WWW chapter served to reinforce the students' learning but the links in the body of the chapters appeared to be distracting. We found ourselves wondering about the value of these links. They encouraged browsing and unstructured investigation while those in the activities formed part of a planned inquiry. There were a few occasions during the session when the interactions were cognitive in nature.

Summary and Conclusion

Observations of student behaviours did not provide confirmation of our contention that the planned environments would encourage cooperation, reflection and articulation among students. The use of the collaborative setting was expected to yield a far higher amount of cognitive interaction between the learners. There were a number unexpected outcomes relating to the influence of the printed guide and the investigative activities on the extent and forms of the interactions observed. In all groups, there were considerably more procedural interactions than anticipated. In some cases, this was brought about by student uncertainty in the unfamiliar environment, elsewhere it was brought about by students establishing working patterns. It was clear

to us after observing the students that any new learning environment would likely reflect this outcome. We would expect if these students attempted other WWW activities now, there would likely be less of these interactions. However the procedural interactions associated with cooperating behaviour would still remain.

Expository interactions often involve articulation and tend to reflect lower levels of cognitive engagement but they help to build understanding by the passage of information and content between learners. In ideal circumstances, expository interactions can and should initiate cognitive interactions. There were many instances in this study where students exchanged ideas and views that could have led to higher-order thinking and exchanges but didn't. Often this was as a result of one student failing to attend to what the other was saying and not extending the item under discussion. Even the most cooperative students tended at times not to listen to what their partners were saying. One factor contributing to this appeared to be the lack of learning goals. The activities did not require students to derive any particular or agreed outcome. Also, the large amounts of textual information and links appeared to distract students, encouraging browsing and unstructured inquiry.

We felt that the principal reasons why there were fewer cognitive interactions than expected and why the number and forms of interactions varied within the different groups were attributable mainly to: group composition, inappropriate composition of groups can lead to non-collaborative environments; lack of instructional support, in instances where students are not guided by instructional support, they can choose to follow paths of their own choosing and avoid activities which the instructor may wish them to complete; inappropriate information display, it does not appear appropriate to use large amounts of text and investigative activities in WWW pages; inappropriate design for collaborative learning activities, in collaborative settings, activities need to be designed specifically with collaborative components and suggested roles for group members that encourage discussion and articulation; lack of learning goals, the students were not guided by any particular goals or stated outcomes; and distracting elements, the inclusion of links and examples in textual and content related sections of WWW materials can distract some learners from the information being presented;

To gain maximum advantage from the collaborative and investigative environment, we suspect that more ideal forms of implementation are those where: group composition is more carefully planned; where students are required to provide feedback of some form on their outcomes as an inducement to maintain focus and complete activities; and where this form of learning exercise is introduced after students have become more familiar with the WWW; and where more adaptive forms of scaffolding providing selective assistance are employed, for example, through an instructor or context sensitive help in the programmed materials. We intend now to revise our instructional materials to accommodate the changes suggested above and to repeat the study. We will look to see whether the changes are associated with increased levels of student collaboration, reflection and articulation and increased levels of cognitive interactions.

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