EXPLORING COLLABORATIVE ONLINE LEARNING

David D. Curtis
david.curtis@flinders.edu.au

Michael J. Lawson
mike.Lawson@flinders.edu.au
http://wwwed.sturt.flinders.edu.au/edweb/staff/lawson.htm
8-61- (618) 8201 2829
School of Education
Flinders University of South Australia
GPO Box 2100
Adelaide 5001

ABSTRACT

An investigation was carried out to determine the extent to which evidence of collaborative learning could be identified in students' textual interactions in an online learning environment. The literature on collaborative learning has identified a range of behaviors that characterize successful collaborative learning in face-to-face situations. Evidence of these behaviors was sought in the messages that were posted by students as they interacted in online work groups. Analysis of students' contributions reveals that there is substantial evidence of collaboration, but that there are differences between conventional face-to-face instances of collaborative learning and what occurs in an asynchronous, networked environment.

KEYWORDS collaboration, learning behaviors, textual interaction

I. ONLINE COLLABORATIVE LEARNING IN HIGHER EDUCATION

Changes in both the levels of funding and the profiles of students have led to an increasing emphasis on the use of flexible methods of course delivery in higher education and as part of that trend there is increasing interest in the use of communication and information technologies (CIT). The availability of flexible learning resources has in turn led to the increased use of flexible delivery methods based on CIT for on-campus students. This has raised questions about the effects of these methods on the quality of interaction among students and between students and teaching staff. In this paper we address one of these questions that focusing on the student-student interaction in a flexible delivery system.

Caught in the midst of conflicting demands for increased efficiency in systems of delivery and improvement in the quality of teaching, universities face some difficult decisions for which they have access to very limited information. Whether flexible learning will influence quality outcomes and whether increased efficiency can be achieved through the use of CIT remain open questions. There appears to be an implicit assumption that efficiencies can be achieved through the use of CIT, but it is clear that setting up to use such technologies entails high infrastructure and staff development costs and may require the "re-engineering" of course delivery processes. It would not be in the universities' interests for such re-engineering to result in a decline in the level of student satisfaction. The lone student scrolling through pages of on-line text is a step backward in terms of quality of teaching and learning. There is therefore a need to gather information about the experiences of students engaged in study in the new flexible delivery modes.

In this study, online interactions among students in higher education were investigated. Interactions among students make positive contributions to students' learning (Laurillard, 1993; Moore, 1993; Ramsden, 1992). There is a question about whether this belief is justified in the case of online

learning environments because the interactions among students are mediated, there is an absence of non-verbal cues, and text-on-screen is a very limited mode for what should be semantically rich exchanges. In this study we sought evidence of good quality interactions among students who are not present in the one physical site from data obtained from students' online exchanges. Our focus was on the extent and depth of on-task activity (numbers of contributions and the 'depth' of those contributions), social chat, extent of collaboration, possible gender influences, mutual explanations (seeking clarification and providing information to peers), and regulatory behaviors (encouraging effort and monitoring peers' efforts and contributions).

A. Previous research

One way to implement high levels of interaction among students, and thereby to increase both the quality of students' learning experiences and the efficiency of delivery, is to implement collaborative learning. Much previous work on collaborative learning has focused on face-to-face situations, while in this study, the focus is on collaboration in an online learning environment. Online interactions differ in quite important ways from face-to-face discussion. Online interactions lack the non-verbal cues that are a component of face-to-face contact, and this may reduce the extent of the communication that occurs. Much online conversation occurs asynchronously, with substantial delays in receiving a reply. This may have both advantages and disadvantages for the participants. The lack of spontaneity associated with a seminar group gathered around the one table may be offset by the possibility of having greater time for reflection and generation of a considered response.

B. Collaborative learning

Dillenbourg and Schneider (1995) make a distinction between *cooperative* and *collaborative* learning. They indicate that *cooperative learning* is "… a protocol in which the task is in advance split into sub-tasks that the partners solve independently". *Collaborative learning* describes situations "… in which two or more subjects build synchronously and interactively a joint solution to some problem". This distinction places greater emphasis on the extent and quality of the exchanges that occur within groups of students in collaborative environments. With cooperative tasks, participants could agree on the elements of the task and distribute those across group members who would work independently until each has completed her/his component. The separate components could then be assembled to produce the final product. It is clear that some authors, e.g. Johnson & Johnson (1996) use the term cooperative learning to describe the higher level processes that Dillenbourg & Schneider would label collaborative. Clearly, an important component of collaboration is the discussion that occurs during task engagement, since the cognitive benefits that are claimed for collaborative learning (Pressley & McCormick, 1995) must be mediated by the verbal exchanges among learners. Verdejo (1996) emphasizes this theme, basing collaborative learning on a "conversation or dialogue paradigm". Henri and Rigault (1996), in addition to the shared approach to tasks and student interdependence, also refer to greater student autonomy in distinguishing collaborative from cooperative learning.

In reciprocal teaching (Brown & Palincsar, 1989) interactions among students have been shown to exert positive influences on students' learning. Reciprocal teaching is a form of collaboration and there is evidence that in the discourse in which learners articulate and share their understandings, there is potential for sharing the cognitive load of the learning task (Dillenbourg & Schneider, 1995), for greater on-task engagement (Cavalier, Klein, & Cavalier, 1995), and for greater mutual explanations (Cavalier et al., 1995).

Johnson & Johnson (1996) provide a sound theoretical basis for collaborative learning arguing that it has been described in terms of cognitive developmental theories, especially from a Vygotskian perspective; from behavioral learning approaches; and on the basis of social interdependence theory. Collaboration in a seminar does allow for scaffolding of thinking for student and provides immediacy of feedback. The behaviors that characterize positive social interdependence include giving and receiving help, exchanging resources and information, giving and receiving feedback, challenging and encouraging each other, and jointly reflecting on progress and process. Positive social interdependence is contrasted with individualistic and competitive work environments. Where people work in relationships in which each individual depends upon others within the group, that is where reciprocal dependencies exist, they achieve more individually, they make greater effort to achieve, they experience greater social support, and they report feelings of greater self esteem than they do in

competitive and individualistic settings (Johnson & Johnson, 1996). Johnson and Johnson (1996) also note that the effect sizes, for the dependent variables just listed, favor collaborative approaches even more when the task is more complex and involves greater problem-solving and creativity.

Could such benefits be associated with collaborative learning that was not face-to-face? In commenting on technology assisted collaborative learning (TACL) Johnson & Johnson (1996) note that "conceptual models of how technology and teamwork may be productively integrated are practically nonexistent" (p. 1038) so that there are few guidelines to direct the efforts of teachers who might like to implement TACL. Levin (1995) supports this view, but does provide a framework for organizing network-based learning environments as a first step towards the development of a theory of online interactive learning. Indeed, since the Johnson &Johnson (1996) paper, substantial work on collaboration in online environments has continued. Both Verdejo (1996) and Henri and Rigault (1996) add to the emergence of theory. They take a conversational approach to understanding the role of computer conferencing in supporting online collaborative learning, but also draw attention to the components of discussion moderation and management. Gunawardena, Lowe, & Anderson (Gunawardena, Lowe, & Anderson, 1997) analyzed the content of an online debate to identify elements of knowledge construction among participants, but in doing so, also sought evidence of collaboration among participants as a component of the knowledge construction process. Hiltz (Hiltz, 1998) has demonstrated that collaborative learning can lead to learning outcomes comparable with those achieved in face-to-face classes. Harasim et al. (1995) provide extensive guidelines to initiate, sustain, and manage online discussion. These sources, and the authors' experience in online teaching, were used to generate sets of guidelines, for both online interaction and for collaborative work, that were distributed to students at the beginning of the course.1

C. Types and roles of interaction

In a seminar room effective interaction needs to be managed in order to help students to generate deep understanding. Moore (1993) asserts that this management involves three key types of learning interaction: interaction with resources; with teachers; and with peers. The quality of each of these types of interaction is of concern in both face-to-face and online environments. In the latter, Hansen (1996) reminds us that a new element of interaction is introduced – the interaction of both the teacher and the learner with an interface.

Interaction with good quality resources in an online environment is often not a major difficulty. Although distance education may be associated with a restricted set of learning resources the new technologies are reducing this problem for both lecturers and students. Indeed even for on-campus students an increasing proportion of the resources they access are online.

In on-campus study students have access to interactions with academic teachers in seminars and in individual consultations. In online teaching such interaction is available, though it is mediated through some form of CIT. The one-to-many interaction of the lecture and seminar that comprises most of the student-teacher interaction for the many students who do not seek individual consultations with their teachers, is often replaced by one-on-one interaction via CIT. However, for the lecturer this interaction occurs at the expense of efficiency because mediated one-on-one interactions, such as email interchanges, are easily initiated by the students and can be very time-consuming.

Interactions among students in the online situation may be more problematic. Laurillard (1993, 99-105), in developing a principled analysis of media use in higher education, provides a detailed model of high quality teacher-student interaction, a model based on a staged, iterative dialogic structure for the interactions between teacher and student. Encouraging such high quality interactions among students may achieve both quality and efficiency goals, but do they occur? We wanted to examine whether the richness of the interactions described by Laurillard was present in online student-student interactions.

Paulsen (1995a) describes alternative ways of implementing Moore's (1993) three types of interaction in online environments, alternatives that should encourage more effective student-student interaction. For that purpose he lists options such as symposia, debates, role plays, case studies, discussion

1 Copies of these guidelines are available from the David Curtis.

groups, brainstorming, and project groups. Following Paulsen, the task set for the participants in this study required groups to act as consultants to educational and training organizations (with which they were all very familiar) and to make recommendations on ways in which CIT could be used to achieve the organizations' goals while maintaining quality in service delivery. This task had elements of role play, case study, and project group approaches.

D. Computer-mediated communication

Over recent years much attention has been paid to the use of computer-mediated communication (CMC) in learning, and especially in distance education (e.g., Daniel, 1995; Ellsworth, 1995; Grint, 1992; Harasim et al., 1995; Hesketh, Gosper, Andrews, & Sabaz, 1996; Paulsen, 1995b; Szabo, 1995). Definitions of CMC vary but virtually all observers include email, chat, and computer conferencing while most also include access to information, e.g. the use of online databases. With the convergence of communication and information technologies, it is now common to find references to desktop video-conferencing as a CMC application. Indeed the term computer conferencing is used in different ways: those who come to it from the perspective of email and bulletin boards use the term to refer to asynchronous structured text based interactions, while those who have been involved in video-conferencing refer to synchronous interactions that may include video, audio, and document sharing, but that do include real time text interactions.

The major focus of this study is on asynchronous interaction, the form of interaction that is most common in current online courses. In this discussion computer conferencing refers to the use of a web-based application that enables participants to create and edit messages that are stored in an area that is accessible to group members and that organizes messages into 'threads' of conversations.

It was our intention to use an email discussion list for part of the topic, during which time students introduced themselves, and to use the computer conferencing component of *Blackboard Classroom* for that part of the topic that was to be the main focus of this investigation of online collaborative learning. However, as reported in the results, the students spontaneously demonstrated a need also to use synchronous communication.

Thus it has been the purpose of this research to examine the nature of the interactions among students working in small collaborative groups in terms of collaborative learning behaviors and the constraints and affordances of the medium. Such an examination should provide better estimates than are currently available of the effect of online study environments on the quality of interactions among students.

II. RESEARCH QUESTIONS

As Johnson and Johnson (1996) point out, there is a very strong theoretical basis for collaborative learning, but much of that body of theory is derived from studies of face-to-face interactions among learners. The major question of interest here is: "To what extent can the components of collaborative learning be identified in the online interactions of students placed in collaborative learning groups?"

Students who choose to learn in online situations do so because of distance from the institution offering their chosen course, work commitments, or family commitments. They require flexibility in their study arrangements, and online learning is one way of participating in their chosen courses. This flexibility exists in that students may study where and when they choose. In general, while learning in an online environment, students' interactions are restricted to text only messages on screen. This medium of interaction may inhibit the degree of collaboration that is possible by limiting the extent and depth of interactions. However, since this online interaction is much more than most students would normally experience in a distance learning course, they may perceive that the experience enhances the interactions available to them. This leads to a subsidiary question: "To what extent does the text-only online environment inhibit or enhance the collaboration that occurs within small project-based groups?"

A. Participants and procedures

Twenty four students (18 women and 6 men) undertaking either a *Bachelor of Education in Adult Education* or a *Graduate Diploma in Adult and Further Education* who were enrolled in an existing online course *Internet and Education* during semester 2, 1998 were involved in the study. Five

students withdrew from the course during the semester. All participants were mature age students and most worked either in the Technical and Further Education (TAFE) or Vocational Education and Training (VET) sectors or were employed in training roles in enterprises. While most students were located in Adelaide (South Australia), ten lived outside the metropolitan area, including five from interstate. Clearly, for many students, face-to-face meetings were not feasible. All used email and the web comfortably, although there was variation in their skill levels.

Within this course, students undertook three assigned tasks. Prior to the assignments, all students were required to subscribe to an email discussion list that had been established for the course and to participate in a 'get to know you activity' in which each posted an introduction and responded to others' introductions.

The first assignment was a cooperative activity in which students selected a topic for investigation. They reported to the class as a whole on their investigation in stages and received feedback from their peers as they reported. This interaction occurred via the class email discussion list. The second, and major, activity required students to work collaboratively in small groups to develop a set of recommendations for the implementation of internet based communications services and information resources in an education or training program. Each group produced a single composite group report. Guidelines for their interaction were provided in the learning resources for the topic and were further explained in discussion with all students via the class email discussion list. The final task, an individual one, was the development of a learning resource using one of the services that was investigated as part of the collaborative activity. Online interactions for the first two assignments were a compulsory component of the course and formed part of the assessment for it. Of the 19 participants who completed the course, only 13 students worked in groups. Those who elected not to participate in group work either experienced illness or had unusual work requirements.

The primary data source was the log of interactions that occurred among groups of students on their collaborative projects. Most collaboration occurred using the *Blackboard Classroom* program, although as discussed later, students also used the telephone and fax to communicate with each other. *Blackboard Classroom* is a web-based application that facilitates: the provision of course information; the distribution of learning resources; communication between teachers and students and among students, both as a whole class and in separate discussion forums; file sharing; and online assessment and feedback. For this study, communication services for small groups of students were the main means of interaction and the main focus of investigation.

Groups of students were self selected. An email message describing the purposes and processes of the task, with suggestions for group tasks, was circulated to all students. Students were invited to respond, nominating topics, and other students then replied, electing to join particular groups. Group size varied from 2 to 4. No attempt was made to control group composition on either a gender or prior achievement basis.

Each group in the investigation was regarded as a case and the focus of the analysis was the online discussions that were recorded for the group. Online exchanges were email messages that were circulated among group members and the messages that were posted to the group's private discussion board. The first author, who was also the academic teacher for this topic, was a member of each group forum in order to fulfill a mentoring role. The intention was that the bulk of the communication would occur via the discussion board. However the design of the interface was such that an option to send an email message to the group was more readily available (i.e. fewer mouse clicks from the entry point) and it seems that students preferred to use email.

Students were able to contact each other outside the group forum by personal email, fax, or by telephone. There is evidence that some exchanges between students did occur via private email messages, fax, and face-to-face meetings. From discussions with individual students this seems likely to occur when one student disagrees with the contribution of another: rather than express disagreement 'publicly' through the class discussion list or conference forum, critical comments were offered privately. Indeed this approach had been advocated in guidelines provided to students because online, text-only interactions can lead to misunderstandings due to the limited information capacity of the medium compared with the relative richness of the vocal and non-verbal interactions of face-to-face learning environments. Further, several of the groups organized synchronous chat sessions to

supplement the other forms of communication, and because of the software being used, it was not possible to capture those interactions. For these reasons, the researcher was not able to access all interactions among students and those interactions recorded may include a bias towards positive and supportive comments.

B. Research methods

The study was exploratory and attempted to identify elements of face-to-face modes of collaboration in the online environment. These behaviors are enumerated in the data analysis section below. The extent to which text-on-screen as the dominant medium of exchange limits (or possibly enhances) collaborative behaviors was investigated, but since a comparative method was not used, only tentative conclusions based upon claims in the literature (e.g. Harasim et al., 1995) about the benefits and disadvantages of this medium of interaction are offered.

The number and content of text contributions made by group members in their online interactions via email messages and postings to the group discussion board were analyzed seeking utterances that were indicative of the behaviors that are reported for other forms of collaborative learning. Student evaluations of the topic were also a source of information for this study. Johnson & Johnson (1996) list the following major types of behaviors in collaborative learning situations:

- giving and receiving help and assistance;
- exchanging resources and information;
- explaining elaborating information;
- sharing existing knowledge with others;
- giving and receiving feedback;
- challenging others' contributions (cognitive conflict and controversy leading to negotiation and resolution);
- advocating increased effort and perseverance among peers;
- engaging in small group skills;
- monitoring each others' efforts and contributions.

Other behaviors, such as organizing group work, initiating further interactions, and commenting or reflecting on the medium were also anticipated. Other utterances are also anticipated. For example, Cook (1997) and Bonk et al. (1998) identified both repetitive and social elements in students' interactions at the expense of task-related exchanges in courses in which online interactions were an optional supplemental form of interaction to the dominant face-to-face interactions. A coding scheme for utterances that indicate the above listed behaviors was developed and applied to the records of interaction that occur in the email exchanges and discussion forums. A number of coding schemes have been trialed by others. For example, in their analyses of an online debate, (Gunawardena et al., 1997) developed a scheme grounded in the debate that they studied. They were critical of other schemes, e.g. those of Levin and of Henri (cited in (Gunawardena et al., 1997)), but also commented upon the limitations of the debate as a vehicle for knowledge construction, and by implication, collaboration, which may suggest that different purposes of investigation may require different schemes of analysis. Since our primary concern was the identification of the classical elements of collaboration in an online environment, we based out scheme largely upon the components of collaborative behavior described by Johnson & Johnson (Johnson & Johnson, 1996).

Three sources of data were available to answer the two research questions posed. For each group, information on the number and form of interactions was collected, although as indicated earlier, information on private email messages, fax transmissions, and chat exchanges was not available. For each group, the content of email messages and postings to the discussion board was collected and analyzed. Only student messages, and not those contributed by staff, were analyzed. All students were asked to complete a voluntary and anonymous subject evaluation form. In particular, students' views about the collaborative component of the course and about the software that was used were sought. Analyses of these data are presented below.

III. RESULTS

A. Summary of online interactions

Students worked in five groups, although Group 5 comprised the six people who elected to work alone. A group area was established for these students and they were invited to use it to keep in touch. This group was relatively inactive and only three members made any contributions. The forms of interaction that are recorded in Table 1 are: email messages, postings to the group discussion board, and file up-loads. Although there is anecdotal evidence for chat sessions, telephone calls, faxes, and face-to-face visits, they could not be tracked and so are not recorded in the table.

Although students were encouraged to use the group discussion board, most of the recorded communication occurred via group email messages. It appears that students were more familiar with email and were more comfortable using it than using the discussion board. The design of the interface also enabled an email message to be sent to the group three mouse clicks from entering the course home page. Getting into the discussion board required four clicks, and then reading a message and replying to it required at least two further clicks, but could have required many more depending upon the location of the message within a thread. Several students did however comment favorably on the structure of the discussion board messages indicating that it was very easy to navigate through earlier discussions to find out "where the discussion was going" rather than try to sort through volumes of email that were mixed with other work related email messages.

In the five groups, there were 198 email messages, 24 postings to a discussion board, and 10 file up-loads. There was a wide range in the frequency of interactions across the groups, from 16 to 160, the median number of interactions being 90. Within each group there was also variation in the pattern of contributions. In Groups 1 and 5 there was a relatively even pattern of contribution, though Group 5 was the least active group. In each of the other groups the pattern of contribution was quite uneven, with some students emerging as dominant contributors. In Group 4, the individual who contributed the least effectively withdrew and decided to submit an individual paper.

Those students who contributed more are likely to have been 'natural leaders' within the groups. In Group 2 two forms of leadership were in evidence: one student made many contributions that were classified as organizing group work and initiating activities while another made a greater proportion of contributions that were classed as giving help and feedback. Other factors likely to influence the extent of contribution are the availability of time and interest in the topic.

Table 1: Summary of online interactions

Group	Email messages	Discussion board postings	File up-loads	Individual student contributions
Group 1	22	5	6	27
Group 2	66	17	1	83
Group 3	57	1	2	58
Group 4	45	0	1	45
Group 5	8	1	0	9
Course totals	198 (85.3%)	24 (10.3%)	10 (4.3%)	

Only Group 2 began to make effective use of the structure available through the discussion board. The structure of their messages is shown in Figure 1. The earliest discussions to occur within the group were conducted via email while they negotiated the topic. They then began to use the discussion board and to up-load files, but during the final stages of submitting drafts and sending and receiving comments, reverted to group email. It seems that students were more comfortable in attaching documents to email messages than in up-loading files to the group area.

B. The analysis of text

The principal hypothesis of this study is that the behaviors associated with collaborative learning activities can be identified in the online interactions of students. The contributions made by group members, either as email messages or as postings to the group discussion board, were analyzed for utterances indicative of the behaviors identified earlier as a result of the Johnson & Johnson (1996) work. In addition, other behaviors including social interactions, organization of group work, initiation of activities, and reflections on the medium were sought. Descriptions of the utterances that were coded as being indicative of the behaviors just described and the codes that have been used for them are shown in an Appendix. The coded behaviors were further grouped within the higher-level categories of Planning, Contributing, Seeking Input, Reflection and Monitoring, and Social Interaction, to reflect more general aspects of students' online interactions.

IV. EVIDENCE FOR COLLABORATION IN ONLINE INTERACTIONS

Data derived from this analysis of the postings of students in Group 2 of this study are summarized in Table 2. The data for Group 2 have been used in this analysis because that group had the highest frequency of contributions.

The analysis of the utterances of group members indicates approximately equal proportions of the general behaviors of planning, contributing, and seeking input. How this balance compares with face-to-face collaborative learning situations is unclear, and whether such behaviors can be expected in the online environment in similar proportions to face-to-face situations is also unclear. The results in Table 2 do indicate, however, that none of the members were 'lurkers' who sought input from the list without making a contribution.

Table 2: Analysis of postings of Group 2

		Participants						
Behavior categories	Codes	G201	G202	G203	G204	Code totals	Code percent	Category percent
Planning	GS	2	2	1	0	5	4.31%	
	OW	0	0	3	5	8	6.90%	
	IA	3	5	3	7	18	15.52%	26.72%
Contributing	HeG	0	2	4	0	6	5.17%	
	FBG	4	1	5	1	11	9.48%	
	RI	2	1	1	0	4	3.45%	
	SK	2	1	2	4	9	7.76%	
	Ch	0	0	0	0	0	0.00%	
	Ex	0	0	0	0	0	0.00%	25.86%
Seeking Input	HeS	5	2	3	0	10	8.62%	
	FBS	8	1	5	2	16	13.79%	
	Ef	4	1	1	0	6	5.17%	27.59%
Reflection / Monitoring	ME	1	0	0	1	2	1.72%	
	RM	6	1	5	4	16	13.79%	15.52%
Social Interaction	SI	1	1	1	2	5	4.31%	4.31%
Person totals		38	18	34	26	116		
		32.76%	15.52%	29.31%	22.41%			

The frequency of planning behaviors seems high and is inflated by the number of instances of 'initiating activity' (IA). In the interactions of Group 2, there were many exchanges seeking to establish and schedule chat sessions so that clarification could occur over work that had been planned using group email and the discussion board. It seems that this is likely to be rather different from face-to-face collaborative learning situations, since the discussion does occur both in real time and face-to-face and there may be less need to seek clarification of tasks. If this is so, guidelines for staff and students should reflect the greater need for such planning activities.

One of the more notable differences is the absence of challenges to the input of others (CH) and attempts to explain and elaborate participants' own contributions (EX) in the interactions of the group being studied. This might be attributed to several factors. In the guidelines prepared before the topic was presented, students were advised to be cautious in their interactions because of the ease with which text only messages can be misinterpreted. In addition, students did not know each other at the beginning of the course and they did not meet face-to-face, although they did participate in email introductions and discussion in an earlier assignment. Despite these earlier online interactions, they did not become acquainted with each other as the topic progressed in the way that does occur in similarly small classes on-campus. These factors may have inhibited the more robust exchanges that are part of a 'challenge and explain' cycle.

Actively seeking help and feedback (HeS, FBS) are prominent behaviors. They do indicate that participants are willing to expose their naiveté in relation to the task or in relation to the software that they are required to use and indicate that their participation is genuinely collaborative. In the Contributing category, we see that the complements of these calls for input – feedback giving (FBG), and sharing of knowledge (SK) – were also relatively frequent.

The pattern of interaction in the reflection/monitoring category is also interesting. Most of this reflection was about the effectiveness of the medium, with very little being focused on task progress. It maybe that this outcome was the result of the novelty of the medium for these students.

Social interaction accounts for almost 5% of all coded contributions. This figure is interesting as previous research (eg Cook, 1997) has indicated that a very high proportion of online interchanges are merely social interactions. However, in her study, the online component was optional. A high proportion of unproductive social interaction appears to be associated with online discussions that are not a compulsory component of the topic being taught and where the online discussion is not related to assessable tasks (Hiltz, 1997). It appears that most of the discussion in Group 2 has been task focused, although there has been some social interaction. However, far from being a distraction from the academic tasks, it is thought that this form of conversation contributes positively to social cohesion, perhaps being the equivalent of the patter that occurs as groups work together in a seminar room task. Some of the social discussion about work situations also contributed to others' understanding of group members' preferences for particular forms of technology as they helped to establish the context in which group members worked.

In summary, the analysis of participants' postings reveals many of the behaviors associated with collaborative learning in face-to-face situations. Challenging others and offering explanations were absent in this study and this may be associated with students' unfamiliarity with each other. The encouragement of more social interactions, perhaps through more structured online self-introductions, could help to overcome this possible barrier. However, it ought be noted that self-introduction was required and modeled by the academic teacher. Guidelines for students and staff that acknowledge this limitation could also promote greater debate, and modeling of appropriate forms of challenge by a group of teaching staff could lead to greater levels of online debate among students. It is speculated that other behaviors, such as planning, appear to be more common in online situations as there is a greater need for overt clarification of goals in the absence of face-to-face interactions.

V. THE INFLUENCE OF THE MEDIUM

A second research question was: "To what extent does the text-only online environment inhibit or enhance the collaboration that occurs within small project based groups?". In the foregoing discussion, reference has been made to possible differences between online and face-to-face collaboration. The online medium seems to influence collaboration along several dimensions.

Although the students who participated in this study were familiar with the basic internet technologies email and the web, they revealed some reluctance in embracing the discussion group, reverting to the use of email (albeit facilitated by the convenience of being able to click a group email button within the *Blackboard Classroom* program). Students did spend some time reflecting on the medium, this behavior comprising 15% of total utterances. They acknowledge the advantages of being able to go back into the records of discussion provided by the discussion board, but need greater encouragement to make more use of it. In part, this could be achieved by a redesign of the interface so that fewer mouse clicks were required to go to the discussion board. In this study, the assumption was made that students who were familiar with email and the web would be able to use the web-based *Blackboard Classroom* software without further instruction. It seems likely that, had students been given more information about the software and its functionality (beyond the information sheet provided), and how to make best use of the various functions available, they may have used it more effectively.

There is an important distinction between real-time and asynchronous forms of interaction. For the reasons outlined early in this paper, there is considerable interest in asynchronous forms of online interaction in higher education. In addition, the current forms of real-time interaction are limited by the capacity of the communication links now available and only the exchange of text is readily accessible and reliable. Despite these limitations, the students in this study chose to engage in chat sessions several times during the study and they did so despite the difficulties of fitting such sessions around work and social commitments and across a time zone. Clearly, there is a need to incorporate among the asynchronous interactions that will increasingly characterize online delivery systems in higher education, opportunities for real-time interactions among students. For now, those interactions will be via the very limited text-only chat sessions. However, the convergence of telephony, videoconferencing, and computing accompanied by increases in communication bandwidth will enable real-time voice communication (using applications like *NetPhone*), with simultaneous document sharing and electronic whiteboards, and eventually fully integrated desktop videoconferencing. To take advantage of this scenario, some research that examines the need for and relationship between asynchronous and real-time interactions is required.

A. Student perceptions of the process

An anonymous evaluation of the topic was conducted via a form placed on the course web site. It included nine questions adapted from the SEEQ instrument (Marsh & Roche, 1994) and a series of open questions relating to the collaborative learning experience. Through these questions, students were asked to comment on the collaborative learning processes that were implemented. In particular, they were asked to comment on the amount of work involved in the collaboration, to identify perceived advantages and disadvantages, and to indicate whether they found the experience valuable. Some of the comments about the collaboration are presented below (as submitted by students).

The collaborative exercise turned out to be more work than I thought. Collaborating over the 'net, with the time delays and with people who I didn't know provided a good exercise in communication. It created some difficulties for me and I realized that I much prefer to communicate in person.

For the small part that I played in the group, I found it very interesting and stimulating. because I spent time offshore the whole process was very disjointed and fragmented making it difficult to maintain a line of thought and adequate contact with other group members. Much of my work was done alone and that will be reflected in my assignments which may or may not be off on a different tangent

This was new to me and it took me a while to get my head around how it was going to work. I felt more time was spent chasing late submissions. As far as physically writing a piece of he assignment not a great deal of work pressure - more so with collaborating and communicating with the group and trying to chat etc. was more of a challenge. Advantages: Thinking with others, new contacts, different work backgrounds. Disadvantages: Can be a time waster, Assignment time (2a) seemed to unnecessarily drag on forever due to trying to catch up with everyone, Rely on others to contribute to your grade.

I found the collaborative group activity to be interesting as it provided me with an interface with other students and thus exposed me to their thoughts on the subject matter. This part of the course was very time consuming, particularly with time differences, work, study and family commitments. The need

for interaction on the assignment caused some delays in completing the task. The assignment should have had equal contributions from all members, however I do not consider that this was the case, as it was very difficult to knock one persons' involvement in the assignment when they have made contributions however they were not included in the final assignment. These situations was further compounded when people simply submitted comments and then were 'off-line' for long periods, probably expecting the assignment to be completed and thus sharing in the result. (Just the task of fine tuning a group assignment is almost an assignment in itself!)

The issues that emerge from students' comments are: they experienced some difficulty in communicating with people who they do not know well; difficulties arise because of time delays in the communication itself (asynchronous rather than real-time); these difficulties are compounded when others do not maintain an agreed or expected work schedule; having to rely on others to complete tasks was a new experience for some (and would clearly require the development of further group skills); and that collaboration as a learning activity itself requires considerable time.

Some of these issues had been anticipated and were a noted in the guidelines that had been prepared and made available to students prior to this exercise. The comments will prove to be useful in revising the guidelines. It will also be necessary to alert future students to some of the specific difficulties that the students in this study experienced so that they are better prepared for the trials of the collaborative learning experience.

VI. CONCLUSION

A. Collaboration in online learning environments

The analysis of students' contributions to online discussions provides evidence of effective collaboration in this online environment. There is some commonality between the collaborative behaviors described by Johnson & Johnson (1996) in face-to-face situations and those observed in this study, although there are some important differences. Those differences include the lack of 'challenge and explain' cycles of interaction that are thought to characterize good interchanges in face-to-face tutorials. The significant presence of planning activities within groups interactions, the extent of which seems to be related to communication limitations imposed by the lack of good real-time interaction support tools, was another notable difference between face-to-face and asynchronous online interactions. However, the use of the related jigsaw method, in which tasks and roles are assigned to individuals in advance by the teacher, it seems likely that this time consuming element would be less evident.

B. The influence of the medium

The medium does influence students' interactions. The students who participated in this study undertook the course as an off-campus one. Without the *Blackboard Classroom* software, their interactions would have been limited to email. It would have been possible to set up an email discussion list for each group but to provide for the range of interactions that were required – group email, the discussion board, file transfer, and chat – would have required a range of separate software tools. *Blackboard Classroom* provided a consistent interface for all the interactions that were used. That interface could be improved by relatively minor adjustments. Most of the comments made by students about the medium related to not knowing how to perform some function or whether and when it was appropriate to begin a new thread using the discussion board. This suggests a need for some additional instructional material on the effective use of the software. Collis, Andernach, & van Diepen (Collis, Andernach, & van Diepen, 1996) commented upon the importance of both pedagogical and technical support arrangements for effective collaboration and noted that there needs to be a high level of integration of the various technical tools that are designed to support it. There is scope for improving the design of the interface to facilitate collaboration in this online environment.

There are important differences in the collaboration that was expected in this study from that reported in others (e.g. Cavalier et al., 1995). In the study of Cavalier et al. (1995), the interaction was constrained in time to a single day in a face-to-face situation, whereas in the present study the collaboration was to be sustained over some weeks, at a distance, and mediated by an essentially text-

based interface. Such differences make direct comparisons between previous reports of collaborative learning and this study difficult.

In our study, we found no evidence of off-task activity among students. Bonk et al. (1998) noted a low level of such activity, but they referred to "social acknowledgments" in students' postings, regarding them as unproductive. Cook (1997) regarded them as being off-task activities. However, we suspect that such utterances have an important social function in enabling learning interactions.

However, despite the differences between the situation that obtained in this study and those referred to previously, there is evidence that successful collaboration as described in face-to-face situations is possible in online learning environments. The medium does influence the interactions that are possible and that student familiarity with the medium and the ease of use of the interface are important factors. Instruction for students in the use of the software and better preparation for the challenges of collaborative learning, especially negotiation and other group skills, are likely to produce a more effective learning system.

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VIII. APPENDIX: CODING SCHEME USED TO DESCRIBE UTTERANCES IN ONLINE COLLABORATION

Behavior categories	Codes	Description	Example
Planning	GS	Group skills: a generic code applied to expressions that encourage group activity and cohesiveness.	I know that [names] have given you good advice, but I think it's worth knowing that you need patience.
	OW	Organizing work: Planning group work; setting shared tasks and deadlines.	I just want to set a time-line for myself. Is everyone OK with that?
	IA	Initiating activities: Setting up activities such as chat sessions to discuss the progress and organization of group work.	I would like to chat on the blackboard. What about this Friday at 7.30pm SA time?
Contributing	HeG	Help giving: Responding to questions and requests from others.	To access the chat room, click on virtual chat in the blackboard; chat screen will come up; click on enter…
	FBG	Feedback giving: Providing feedback on proposals from others.	I like your idea of a generic booklet and everyone contributing aspects of interesting internet services…
	RI	Exchanging resources and information to assist other group members.	"With the implementation of an internet service … there has been a major shift in the communication function in business."
	SK	Sharing knowledge: Sharing existing knowledge and information with others.	I think we also need to give thought to the following. 1. The issues of quality/efficiency in teaching and learning…
	Ch	Challenging others: Challenging the contributions of other members and seeking to engage in debate.	No examples - behavior not identified in the text.
	Ex	Explaining or elaborating: Supporting one's own position (possibly following a challenge).	No examples - behavior not identified in the text.
Seeking Input	HeS	Help seeking: Seeking assistance from others.	Does anyone know how to edit/add/append data on the student pages?
	FBS	Feedback seeking: Seeking feedback to a position advanced.	What do you think about answering the questions that … has put forward?
	Ef	Advocating effort: Urging others to contribute to the group effort.	Haven't heard from you for a while. Are you still with us?
Reflection / Monitoring	ME	Monitoring group effort: Comments about the group's processes and achievements.	I believe the overall contribution and collaboration of working as a group requires an increase within itself as part of our learning.
	RM	Reflecting on medium: Comments about the effectiveness of the medium in supporting group activities.	The email for the discussion group seems to work OK for me. You know it has gone through because you actually receive your email back almost straight away if it has worked.
Social Interaction	SI	Social interaction: Conversation about social matters that are unrelated to the group task. This activity helps to 'break the ice'.	Regarding chat - my weekend is pretty hectic - I have my family flying in from Greece … so the Greek festivities will be in full swing.

IX. ABOUT THE AUTHORS

David D. Curtis and Michael J. Lawson are in the department of education at Flinders University.