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Instructional Design Alternatives to Help Facilitate Distance-Based Cooperative Learning Projects within a Post-Secondary Framework

by

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies for acceptance, a thesis entitled “Instructional design alternatives to help facilitate distance-based cooperative learning projects within a post-secondary framework” submitted by Bradley F. Johnson in partial fulfillment of the requirements for the degree of Master of Science.

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Dedication

To Brigitte for her *patience* and support.

Je t'aime Brigitte.

Abstract

The accessibility of low-cost communication media, including computers and the internet, coupled with the increasing maturity of groupware, make it possible to integrate Cooperative and Distance Learning. However, care must be taken to ensure appropriate use of technology by understanding the “fit” between groupware and group projects. Analysis has suggested a multi-stage task model in which the interaction requirements vary from stage to stage. In an effort to test a model adapted to indicate interaction levels for any given task-stage, two instructional designs were generated varying audio and FTF. An appropriate “fit” appeared to be measured best by participant’s “Satisfaction with the Software”. However while task stages as described by Jigsaw I tasks were evident, and tended to provide support for Daft & Lengel’s model, the results of this study did not provide unequivocal evidence in favour of either audio or face-to-face communications modes for tasks such as the one used.

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Chapter 1: Introduction

In 1980, Kulik, Kulik, & Cohen performed a meta-analysis[1] of a group of studies that compared various computerized media in education. The experimental procedure in these studies was to compare two or more different media delivery systems, for example, a computerized tutorial and face-to-face (FTF), while using them to help deliver educational content. In some studies the instructors were different in each media condition while in others the same instructor participated in both media conditions. When the instructors were different across conditions, effect sizes of about .51 were recorded (effect sizes range from 0 to 1.0) indicating larger instructional gains e.g., higher marks. In situations where the instructor was the same across conditions, the effect sizes were closer to .13. Howell (1992) suggests that an effect size of .80 indicates a large effect, .50 indicates a medium effect, and .20 indicates a small effect. Thus the effects due to media were small while the effects due to instructors was medium. The conclusion was that the instructor, not the media, made the difference.

According to Clarke (1983), how an instructional sequence is put together is more important than which media is used in the sequence. The activity of constructing an instructional sequence, including determining the most appropriate media, is called instructional design. The two branches of instructional design that we are interested in this study, are cooperative learning and distance education. Cooperative learning, or the process of learning through peer interaction (group work), has been shown to be significantly more effective than competitive learning (Johnson & Johnson, 1990) but requires high levels of interaction between the students (Johnson & Johnson, 1992). Although cooperative learning has proven itself in the classroom, no affordable and accessible technology has been found to allow cooperative learning to be integrated into distance education. That is, the communications technology required to support cooperative learning over distance, has been too expensive and the software too primitive. However, huge decreases in the cost of computers and networked access (internet), coupled with a growing maturity of the kinds of software necessary to help people communicate, has made the integration of cooperative learning into distance education curricula possible. A review of current research found that although the theoretical groundwork had been laid, no integrated effort had been made to systematically determine the best way to implement distance-based cooperative learning.

The Theoretical Framework

Moore (1983) has suggested that the "distance" in distance education is a function of the level of interaction between students and instructors, and of the flexibility of the instructional design. He calls this transactional distance. The ways to decrease transactional distance are to increase interaction between students, or produce more flexible designs. Moore also felt that there were three types of interaction that should be encouraged in all instructional sequence: students with students, students with the material, and students with the instructor (1990). One of the things that cooperative learning is particularly good at, is increasing the interaction between students and material. Thus an integration of cooperative learning into distance education curriculum should help to reduce transactional distance.

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[1] Meta-analysis is a technique that allows comparisons between studies even though the

Clarke (1983) suggested that a fruitful area of research was to look at tasks and how media could support them. Dicks (1992), Poole & Holmes (1993), McGrath (1990), have suggested that group tasks may be composed of as many as four distinct stages. Each stage is typified by the type of activity, and the level of interaction, one may find between group members. Dicks suggests that an appropriate area of research is in determining optimal levels of computer-mediated support for task activities. This would, of course, apply to task-stages as well.

The criteria for determining when computer-mediated support is appropriate for a given task or task-stage, encapsulates the idea of "fit" (Gutek, 1990). That is, the software must be appropriate for to the task being performed. Richer communication modes, FTF for example, may not always be the most appropriate for a given task (Dicks, 1992; Williams, 1977). Dicks suggests that a measure of the fit of the software may be user satisfaction with the software.

These seemingly disparate pieces go together quite nicely to provide a direction for research. Transactional distance may be reduced by increasing interaction between group members. Cooperative learning would help increase interaction between group members. Computer Mediated Communication (CMC) support must be appropriate to the needs of the task or task-stage. When the "fit" between support and needs is good, user satisfaction should be high. However, determining "fit" may, at least in the sense of reducing transactional distance, be a function of determining the level of interaction a particular task may require.

Dicks suggested that Daft & Lengel's organizational model (1986) could help determine required levels of interaction for various group tasks (1992). Using the ideas of task and information equivocality and uncertainty, Daft & Lengel

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measures may be different.

constructed a model to help determine what sorts of tasks would require higher levels of interaction between group members. It should be possible to determine interaction levels for tasks or task-stages by judicious application of their model. Specifically, Daft & Lengel's model suggested the types of interaction patterns one could expect for a given range of equivocality or uncertainty. A task analysis could, for example, be matched against their description and a likely level of interaction determined.

Purpose of This Study

This thesis provided an opportunity to develop a methodology for the integration of group work into distance education programmes through the appropriate use of groupware. A closer inspection of learning theory and instructional methodologies suggested that increasing interaction between group members could help to reduce transactional distance (perceived distance). It was determined that a model was needed to help understand the relationship between task types and levels of interaction.

An organizational communications model, first proposed by Daft & Lengel (1986), was adopted to serve as the model for determining the levels of interaction one could expect for a given set of interaction patterns. A general task description was derived with the aid of cooperative learning methodologies. When matched against a hypothesized set of interaction patterns (derived from the task analysis), it was possible to use the model to estimate the likely level of interaction. This, in turn, suggested a groupware mix that should provide appropriate support for group projects.

In an effort to "fine tune" the methodology, two instructional designs were generated. Each of these designs were identical in all regards save one: the beginning stage of a group project. The communications mode was varied between designs, that is FTF interaction in one design and CMC in the other. A set of evaluation criteria were determined to help find the better instruction design and the study was carried out.

Chapter Outline

This thesis was organized by chapter. Chapter Two is a literature review which defines instructional design, cooperative learning, transactional distance, the idea of “fit”, and task-stages. Chapter Three describes the adoption of Daft & Lengel’s model and the development of an evaluation strategy. A research question is offered at the end of the chapter. Chapter 4 and 5 describe the methods and results respectively. The results include demographics, satisfaction data, and a protocol analysis to help determine the existence of task stages. Chapter 6 discusses the findings including a usability analysis of the software, the protocol analysis and the satisfaction data. A discussion of more general implications for instructional designers is followed by some suggestions regarding future research. Finally, the chapter is wrapped up with a section offering some general conclusions about the study.

Chapter 2: Instructional Design and Distance Education

Distance education has long suffered from a lack of affordable communications systems. Video conferencing using broadcast technology, for example, is extremely expensive and requires students and instructors to be "on location" where the equipment is located. In rural communities that can mean having to commute to the local video conferencing installation. With the recent proliferation of internet access and huge reductions in the cost of computers, it has become possible to engage in networked communication from one's home or office. Computer mediated communication can help people communicate and work together even when they are not physically proximate. E-mail, chat groups, and audio and video conferencing, are all variations of software that helps people to communicate. Collectively these software tools are called groupware. However, as video conferencing is neither the only type of computer mediated communication, neither is it always the best choice for communication. Studies have shown, for example, that in some cases video or even face-to-face communication will lead to poorer results than will communication by audio (Williams, 1977).

While the possibilities of using computer mediated communications for distance education are many, one application that is gaining caché within the educational community is using CMC to promote cooperative learning. Cooperative learning theory, an area of instructional design that encourages learning from ones peers through engaging in cooperative activities, has shown that students tend to learn more, and to process the content to deeper levels, when working with other students as compared to working alone (Johnson & Johnson, 1990). In fact the title of one of the seminal works in this area was "Learning together and alone" by Johnson & Johnson (1976). However, cooperative learning requires students to interact with each other regularly. Until recently the communications tools were not available to support cooperative learning in distance education. However, computer mediated communication may provide the tools for instructional designers to implement cooperative learning in distance education. And, of course, as the accessibility of computers, software, and low-cost networking become more common, the logistics of implementing distance-based cooperative learning become surmountable.

However, while the pieces seem to be there (cooperative learning theory, software, access), the instructional design community has not had the opportunity to “catch up.” Consequently, instructional models for implementing cooperative learning into distance education are lacking.

The focus of this section is to define all of the components that may interact with each other in a computer supported cooperative learning environment. As will be shown, the process of defining the environment, coupled with the findings of other researchers, leads to the conclusion that an instructional model to help with the integration of cooperative learning into distance education curriculums must include a component for estimating levels of interaction for different group tasks.

Instructional Design & Methodology Defined

According to Gagne and Briggs (1979) “The purpose of designed instruction is to activate and support the learning of the individual student” (p. 4). The activity called instructional design was described by Richey as “… creating detailed specifications for the development, evaluation, and maintenance of situations which facilitate the learning of both large and small units of subject matter.” (1986, p. 9). The design of instruction in the areas of distance education and cooperative learning are distinct from other areas of instructional methodology by virtue of their unique constraints. These constraints are described in the next two sections.

Cooperative Learning

Cooperative learning, argue Johnson & Johnson, has been around for a long time (1991). Even so, they were clear to define what cooperative learning was, and what it was not. In a more recent work, they re-iterated, “Putting students into groups to learn is not the same thing as structuring cooperation among students.” (Johnson, Johnson, & Smith, 1991, p. 1:18). To help clarify their conception of what cooperative learning was, Johnson & Johnson claimed that five basic elements were essential, in order for an instructional sequence to be called cooperative (see Table 1).

Table 1: Five essential elements in a cooperative learning instructional sequence (Johnson & Johnson, 1975; Johnson, Johnson, & Smith, 1991).

1.	Positive Interdependence	-	Success depends upon everyone working together.
2.	Face-to-Face Promotive Interaction	-	When students help each other (over and above doing their own work).
3.	Individual Accountability	-	Each student is accountable for their contribution.
4.	Social Skills	-	Promotes decision making and leadership skills.
5.	Group Processing	-	Discussion of student involvement with the group, group development.

As cooperative learning theory and research developed, variations on the basic structure were put forward and tested. Aronson, for example, developed an approach called the Jigsaw technique (1978). In this approach a group task was structured so that each group member had a role to play. Success of the group was dependent upon each group member completing their role or job. In some content areas this proved easier than in others (Mattingly & VanSicke, 1991). However, the greater problem was one of motivation. It was difficult to structure individual accountability into the group project in such a way as to motivate students and not penalize the other group members. Slavin developed the Jigsaw II technique in response to this difficulty (1983). In the Jigsaw II technique, students were compared to baseline measures. Improvement from each students baseline measure was the criteria for a portion of the students mark. Another portion was based on group performance. In this way he was able to provide a solution, and to address Johnson & Johnson’s third element of cooperative learning, individual accountability.

While a number of variations have been offered, the basic structure of Johnson & Johnson’s original formulation remains largely intact. To integrate cooperative learning into distance educational experiences, the five basic or crucial elements must be addressed. It should be noted, that the emphasis on face-to-face in the element, “Promotive Face-to-Face Interaction”, has perhaps been an unfortunate simplification, especially when considering technological support for cooperative learning activities. Gutek, has suggested that a technology should “fit” what it is being used for (1990). Williams summarized research by suggesting that FTF or video conferencing, was not always the most effective communications medium (1977). In some cases FTF or video conferencing produced better results than did audio communication modes. In other cases, audio communications modes produced better results than FTF or video conferencing. For example, when tasks involved some form of conflict resolution process (for example, arguing a legal brief) it was found that factual arguments tended to succeed when audio was the richest communication mode provided. As well the ability to change another person’s view was more likely when audio was the richest communication mode (Short, 1974). These lead one to the conclusion that FTF is not necessary for all the various kinds of promotive interaction. There may be cases when students can help each other without the need for FTF interaction. A method for determining the sorts of cases these may be, and for generally supporting the kinds of interaction suggested by Johnson & Johnson’s characterization of cooperative learning, is discussed in the next several sections.

The ‘Distance’ in Distance Education

The idea of distance may lead one to think in terms of hundreds of kilometres between participants. The instructor may be hundreds of kilometres from the nearest student. Similarly each student may be hundreds of kilometres distant from the closest fellow student. In other words the term *distance* in distance education is often thought to refer to a geographical separation of participants.

Moore (1983) defines distance in different terms than those given above. He suggests that distance is a function of two variables: dialogue and structure. While dialogue refers to the amount of interaction possible between participants (with each other or with the instructor), structure refers to the flexibility of the instructional sequence. Little interaction and a highly structured instructional sequence leads to greater *transactional* distance. Thus increasing the dialogue or interaction, or creating a more flexible instructional sequence, can effectively reduce the transactional distance between participants.

The idea of transactional distance does not rely on physical distance as a defining characteristic. Rather it allows an instructional designer to ignore, to an extent, physical distance and to focus on flexibility and interaction. If one assumes that technology can facilitate high levels of interaction, then instructional sequences can be designed to minimize transactional distance regardless of physical distance, by increasing dialog and interaction.

Interaction Defined

Most, if not all, learning theories suggest that interaction with content is necessary for learning to occur (e.g., see Wolf, 1988). A feedback loop of some kind must be established so that students may gauge the efficacy of their understanding, and to make accommodation and revisions as necessary (Krippendorff, 1986; Rumelhart, 1989). Moore suggests that there should be up to three types of interactions going on in distance learning situations (in fact, in all learning situations): student-*content*, student-*instructor*, and student-*student* (1989). If, as Moore suggests, there are various types of interactions, good instructional design should address as many of these interaction types as are relevant to the content and situation (Wagner, 1994).

Structural Contingency

Often, technology is applied before its boundaries are known. The idea seems to be that more technology is always better. However, more computing power and more powerful software are not always the best solution to a problem. In some cases, more may even be too much. When technology is applied incorrectly to situations, Gutek (1990) claimed that the “fit” between technology and use of the technology was poor. When the “fit” between technology and use was more appropriate, it was considered a good fit. Perhaps the most useful aspect of Williams meta-analysis (1977) was that the results of video/FTF versus audio comparisons showed some task-types to benefit more from audio than video. Thus the “fit” between the technology and the task-type was good. However, others have shown that, at least in the area of computer mediated communication, people often want or desire the richest communications mediums available (Galegher & Kraut, 1992). Galegher and Kraut performed a study in which a number of media tools were provided. These included e-mail, telephone, computer conferencing, and FTF meetings. There were three conditions: in the first condition participants were allowed only the computer conferencing and e-mail. The second group of participants were able to use the computer conferencing, e-mail, and the telephone. The third group of participants were allowed to use all of the media plus FTF. The study showed that people often opted for the media that provided the richest communication medium even when a less rich one would have sufficed[2]. While it may be true that people will opt for the richest media available, it may also be the case that the richest media isn't always the most appropriate for a given task.

Gutek suggested that software should meet the demands of the users and the tasks being performed, rather than constraining the tasks to the software. Instructional designers should be charged with the same goals: to design instructional sequences that optimize, for example, interaction. Software support should be driven by the demands of the instructional design, rather than the design being driven by the software.

Task-Stages

Recently research has begun to look into the various task-stages through which a group may pass on its way to the completion of a group project (Dicks, 1992; Collings & Walker, 1996; Heeren & Collis, 1993; McGrath, 1990). It was suggested that at each stage of a task different things go on either in terms of activities or types of verbal exchanges. Using a task-analytic approach, group

[2] For a discussion of media richness, and how people perceive richness, see D'Ambra, Rice, &

projects have been broken down into stages according to the types of activities typical of each stage. Four task-stages were generally found corresponding to (1) the initial task determination, task allocation, and political interaction, (2) on task activities, (3) group processing, and (4) construction of deliverable (see Table 2) (McGrath, 1990).

O'Connor, 1998.

Table 2: Task Stages and Their Interaction Patterns.

Task Stage	Interaction Patterns
Task Stage 1 – Beginning Stage of Task	**Determine the task**. In some cases the task needs to be determined by the group (e.g., determine a paper topic) while in others the task activity is described. **Task Allocation**. The task must be broken into areas of responsibility. **Political Interaction**. As a consequence of either task allocation or task determination, dysfunctional relations may develop between group members. These must be corrected by further interaction aimed at ensuring everyone is "O.K.." In this process a group leader may surface.
Task Stage 2 – On Task	Group members are actively working on their bit of the task. In some cases, such as research, this may be a solitary activity.
Task Stage 3 – Group Processing	At different times the group will need to meet and determine the current state of progress. The task may need to be altered and sub-tasks re-allocated.
Task Stage 4 – Construction of the Deliverable	The group must arrange to integrate each of the member's contributions into a final product. Final determinations regarding the deliverable are made here.

It should be noted that task stages, although temporally defined, are fluid in the sense that groups often go back and forth between stages, especially between the second and third stages (Poole & Holmes, 1993).

Conclusions and Directions

In the process of defining instructional methodology, cooperative learning, and distance, a new variable became evident: interaction. Moore seems to advocate a "more is better" approach suggesting that increasing the interaction between students and materials will help reduce transactional distance, and therefore improve the educational experience, e.g., learning. Gutek however, suggests that more is not necessarily better and that software support for any given task should be driven by the demands of the task rather than the software. As well, task analysis reveals that cooperative learning tasks often go through several well defined stages. If each of these stages had different interaction requirements, then according to Gutek, an instructional design should vary the software support available for interaction according to those requirements. However, as will be seen in the next section, no adequate model exists to help determine interaction requirements either for a task or task-stage.

Instructional Design and Interaction in Distance Education

Instructional design of interaction in distance education includes more than simply the flow of information and the media used to facilitate that flow. Wagner (1994) suggests that,

> *"In terms of interaction, effective instructional delivery of voice, video, text, and data signals depends not on the particular media/technology … but rather on the establishment of an effective two-way communication dynamic*." P. 25

She went on to offer a visual model to help establish some perceptual parameters (see Figure 1).

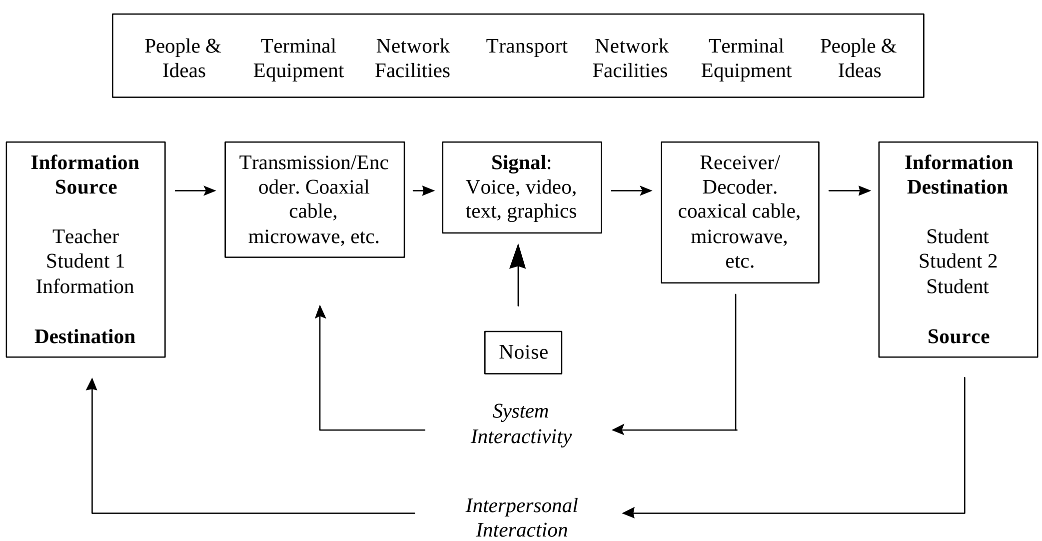

Figure 1: An Interactive Information Transport Model. Wagner, 1994, p. 25.

Wagner suggests that her model should help facilitate the communication dynamic by helping to focus on increasing the interpersonal interaction through well designed instruction that takes into account the level of system interactivity.

Although Wagner’s model is helpful, it does not go far enough. That is, while it describes the interaction flow, it has little explanatory power. If interaction flow rates vary from task to task, for example, Wagner’s model could do no more than alert us to the fact and perhaps point to the bottleneck, if one exists. The model could not, however, explain why different tasks may produce different flow rates.

It is suggested that current research should focus on determining an optimum mix, or best “fit”, of groupware (software designed to help groups work together) for various cooperative learning tasks. A good fit may be described as an appropriate level interaction for a given task so that transactional distance was reduced and learning maximized. An instructional model that would help determine the optimum mix, and therefore help determine the best instructional sequence, was suggested to be a useful tool. Unfortunately, no such tools were found. Or rather, the tools that were found appeared to culminate in Wagner’s model.

The next chapter discusses models that do, in fact, attempt to explain why communication flow rates might vary depending upon task characteristics. As will be seen, there appeared to be adequate theoretical and empirical evidence to enable the use of their communications model to help determine levels of interaction for different task-types and task-stages.

Chapter 3: Adaptation and Evaluation

Daft & Lengel's Organizational Model

Daft and Lengel (1986) developed a model to help determine under what conditions richer communication modes were required. In their definition, richer communication was synonymous with information flow. Higher rates of information flow indicated richer communication levels. Their model was based on the idea of equivocality of task description and uncertainty of information.

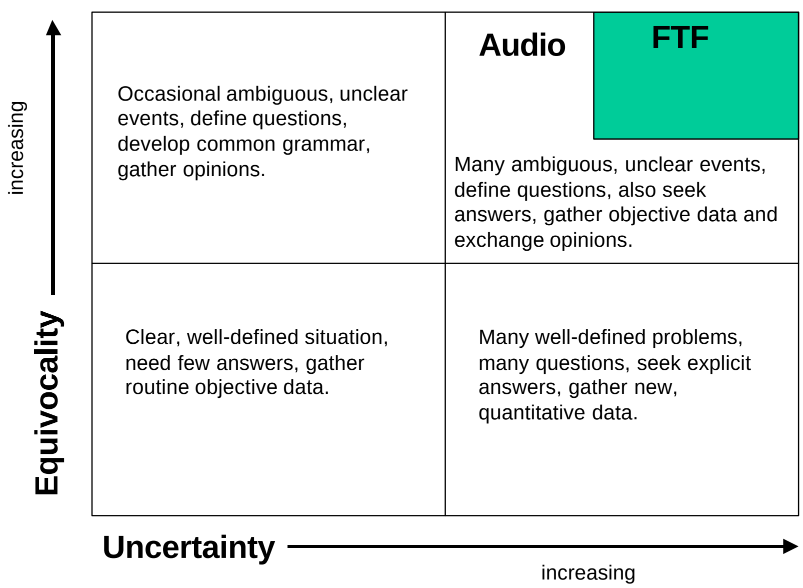

Figure 2a: Daft and Lengel's Uncertainty/Equivocality Model (1986, p. 557)

Equivocality of task description considers that in some cases tasks are fully described while in others not at all. In cases where the tasks are more fully described the actions required for successful completion of the task are well known. When tasks are not well described the task participants must determine what actions would count as promoting successful completion of the task. When the task description is equivocal communication requirements increase. As equivocality drops so too do the communication requirements. Uncertainty of information refers to the idea that when task participants do not know what counts as task information, then the information is uncertain as far as the participants are concerned. As with equivocality, the greater the uncertainty the greater the communication requirements.

Figure 2a was the original description as put forward by Daft and Lengel. Notice that in the top-left and bottom right quadrants that, as compared to the lower-left quadrant, that some elements are either unknown or less well known. In the top-left quadrant, for example, the questions must be defined and a common grammar must be agreed upon. In such cases there are increased rates of information flow until equivocality is reduced. In the top-right corner a combination of uncertain and equivocal information produces even higher rates of information flow. The descriptions of the quadrants provide a criteria for determining the likely communication regions of a given task ***providing*** the task could be described in similar terms. For example, the Ochsman & Chapanis (1974) studies were best described as “clear, well defined situations”. The participants knew what was required of them and only needed to complete the task given them. In one case, the task involved the cooperative construction of a cart. One person had the instructions on how to assemble the cart, and dictated the instructions to the other person, who assembled the cart. In a second task, two people were required to find an address. One had a map, the other had more information on the person they were looking for. In the first case, the task was well described and required little two-way communication. The instructions were given, and the assembler rarely asked questions except for clarification of instructions. Thus a description of the task would most likely be most in line with the description in the lower left quadrant of Daft & Lengel’s model. The second case, however, required higher levels of interaction. Each person needed the other to successfully complete the task, and both needed to interact with the other. It is likely that a description of this task would correspond more closely with the description in the lower right quadrant. This was, in fact, what Ochsman & Chapanis found. The first task appeared to require less rich communication modes compared to the second task.

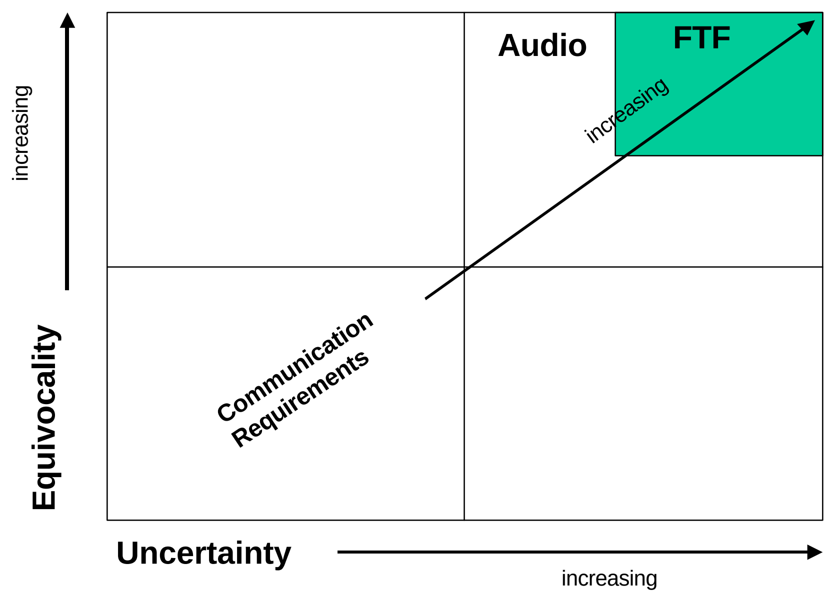

Figure 2b: Summary of Daft and Lengel's Uncertainty/Equivocality Model (1986) restated in terms of communication requirements.

Figure 2b is another way to represent Daft & Lengel's model. In this characterization it is clear that as uncertainty and equivocality increase, so too do the communication requirements. In both figures, the upper right quadrant has been further divided to indicate where audio and video support may be required. This was in line with findings from D'Ambra, Rice, & O'Connor (1998). They asked people to rate media richness and found that FTF was rated the highest followed closely by telephone. Asynchronous modes of communication were rated much lower (see Table 3).

Table 3: Media richness ratings and scale reliabilities.			
Medium	**Mean**	**S.D.**	**Scale Reliability**
Face-to-Face	4.62	0.65	0.86
Telephone	4.03	0.74	0.80
Voice Mail	3.14	0.98	0.75
Email	2.42	.096	0.60
Memo	2.30	0.92	0.54

If one interprets Daft & Lengel's model so that audio and FTF are requirements of the upper right quadrant, then it makes sense that FTF would cover the upper right corner of the quadrant.

As a theoretical model, Daft & Lengel's model seemed to have explanatory and predictive power. If you knew where on their model a group task was likely to fall, a prediction could be made regarding the rate of information flow. However, little work has been done regarding where to place tasks on the model. As a means of determining how best to interpret task placement, data from prior studies was reviewed. That is, the empirical findings of prior studies may provide insight into task descriptions and their associated media requirements.

Williams (1977), for example, performed a meta-analysis of studies that looked into differences between face-to-face or video versus audio only modes of communication when performing various tasks. For most tasks it was found that audio only was as good or better than video or even FTF communication. In particular it was found that tasks with clear descriptions performed much better when the communication mode was synchronous but little better when video was compared to audio (see e.g., Ochsman & Chapanis, 1974).

Table 4: A summary of Williams literature review. In each of these studies the primary communications modes compared were audio versus FTF or video.

Category	Tasks	Media Differences
Cooperative (Chapanis, 1974)	problem solving, information transmission	voice equivalent to FTF but greater than written (i.e. Chapanis
Conflict Resolution (Short, 1974)	negotiation, debates	Decisions based on merit were more accurate in voice vs. FTF, Decisions based on other factors greater in FTF vs. voice
Conflict (Wichman, 1970)	cooperation vs. competition (prisoners dilemma - See appendix A)	cooperative responding greater in richer modes, competitive responding greater in less rich modes
Conflict (Short, 1974)	Conflicts of opinion	Opinion change more likely in audio only followed closely by audio/video then by FTF
Interpersonal Perception (Williams, 1975)	Social, evaluative i.e. job interviews	little media difference although FTF > voice/video > voice but rarely significantly so.

Group Dynamics (Williams, 1975; Krueger, 1976)	Consensus gathering, decision making	Less rich modes resulted in less clear group structure and hierarchy that normally appears spontaneously, concluded a strong influence on group processes.

However, when tasks involved some form of conflict resolution process (for example, arguing a legal brief) it was found that factual arguments tended to succeed when audio was the richest communication mode provided. As well the ability to change another person's view was more likely when audio was the richest communication mode (Short, 1974). For a summary of William's findings, see Table 4.

Two types of tasks or characteristics were found to require richer modes of communication: interpersonal perception and group dynamics (Williams, 1977). People reported feeling that others did not take them seriously when communicating via audio only. Group structure was reported to either not develop or develop poorly when audio was the richest communication mode available to the group. These two task characteristics reveal that at some point in a group process, specifically when these characteristics come into play, richer forms of communication were required.

McGrath (1990) has suggested that during the course of a cooperative learning experience group members pass through various phases (particularly in goal directed learning experiences): (1) Goal setting - define the task, (2) Problem solving - describing the actions, (3) Political interaction - solving conflicts, making decisions, and (4) Project completion and evaluation. The first three are found primarily during task-stage 1, the beginning of a task. The fourth phase is, of course, found in the remaining task-stages. Perhaps the most interesting phase is phase three. In this phase group members are actively involved in a political process where the task characteristics are discussed. Group members must determine, or negotiate a shared task description e.g., determine what the requirements of the task are, what counts as a deliverable, what counts as information, task allocation, and so on. Often there are competing conceptions of what the task should be. For example, in a cooperative task where the topic area is left up to the group and where the interests of group members are diverse, conflicts may develop that require resolution. Before the group can proceed they must first agree on a topic area. Depending upon the distance between competing interests, the process of determining a topic area may damage group interpersonal dynamics. The group relationship may need to be repaired before proceeding on to other stages. Thus the political process phase may easily climb high on the equivocality scale. Similarly this phase may climb high on the uncertainty scale.

Task Composition

A study by Poole and Holmes (1994) suggested a common path along which a group project may be expected to pass. Table 5 provides a summary of task activities and information flow. The communication mode most appropriate for each set of activities is also indicated. Table 5 should be considered a synthesis of the work of Poole & Holmes (1993), Dicks (1992), McGrath (1990), and Williams (1977).

If the temporal ordering and associated task activities are correct, then each set of activities may be termed a task stage. Task-stage 1 may be typified by the activities described. Task-stage 2 may be typified by the activities associated with the second set of activities. And so on. Using this task description, the task-stages were mapped onto Daft and Lengel's model (see Figure 3) to help determine the communications requirements for each stage.

Table 5: Task Activity, Ordering, and Communication Requirement. Adapted from Poole & Holmes, Dicks, Williams, and McGrath.

Ordering	Task Activity	Communication Requirement
1.	Meet Determine task description Determine task actions Perform task allocation	High degree of uncertainty, high information flow. Most likely requires video or FTF
2.	Perform tasks	Low uncertainty, tasks are known and may be performed with minimal interaction.
3.	Updates, processing activities	Low to medium uncertainty, increased information flow. Communication is necessary primarily for status reports.
4.	Assemble Product	Low to high uncertainty, increased information flow. Depending upon the project this may require a wide range of communication modes.

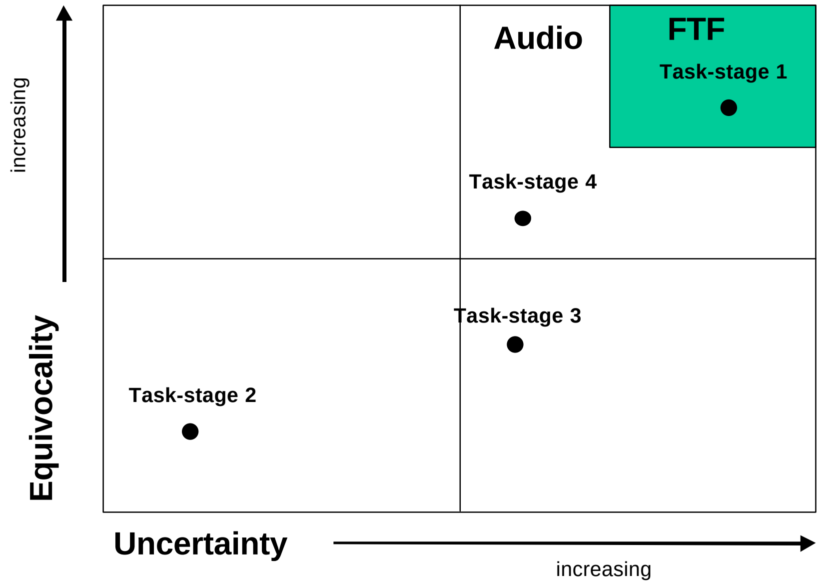

Figure 3: Cooperative Learning task stages mapped onto Daft & Lengel's model.

It was clear from figure 3 that the first and fourth stages of a cooperative learning task had the highest communication requirements.

With this model in hand, it is possible to determine, from task descriptions, the amount of communications support that would likely be required for a given task stage. However, the interpretation of task descriptions and how the model should be used to interpret them, is tentative at best. It seems prudent that the assumptions inherent in the above task-placement be tested.

Evaluation Methods

Evaluation is a crucial step in the design process. In many cases measures for the success or failure of an instructional sequence revolve around achievement. Higher achievement levels indicate higher degrees of success (both for the student and for the instructional design). However, if the instructional sequence is to promote better social skills, for example, then a measure of social interaction may be more appropriate. The types of evaluation tools (i.e. the tools that one could use to help gather data) range widely from test scores to essays to levels of social interaction to levels of motivation.

Three types of evaluation measures were reviewed to determine which would be the most appropriate (flexible and sensitive) for this study. While the most common form of evaluation of learning outcomes is performance, measures of interaction and motivation appear more appropriate. Although it was possible to measure both interaction and motivation, the latter was determined to be the better choice.

Performance Measures

At first glance it may appear that performance measures are a logical tool for evaluating the efficacy of the model we have developed. However, most studies have shown that participants were able to complete their assigned tasks regardless of how mismatched the communication mode and task requirements. Thus if one were to evaluate only performance outcomes it is quite likely that no effects would be found, particularly when comparing different communication mediums. Kulik, Kulik & Cohen (1980), for example, have shown that in studies where only the media have changed, and the evaluation measures included performance outcomes, effects sizes were approximately .13. This indicates that the performance outcomes, although statistically significant, were quite small, often no more than 1 to 3 percentage points of difference.

Quality of Interaction Measures

Although analysis of the dialog between and among group members may provide evidence of the successful approximation of a communication medium to face-to-face interaction, it may not provide the kind of results we are interested in here. If one accepts that the Chapanis series of studies (Ochsman & Chapanis, 1974; Chapanis, 1975; Chapanis, 1977) represent paradigmatic tasks and results, then it is clear that quality of interaction measures can help determine the difference between e.g., FTF, audio, typed, and written dialog in terms of information flow. These studies indicated, for example, that the number of words used in FTF versus textual media (typed, written) were much higher. Similarly the number of sentences, number of unique words, and so on, were also higher. The differences between audio, video, and FTF, while measurable, were not significant. For the purposes of this study it is assumed that an audio channel is always available. If this is the case then quality of interaction measures may produce non-significant results.

Motivational Measures

The types of measures that have frequently been used in the past appear to focus more on questions like, “can people use the tools provided?” In many cases the answer has been “yes.” Unfortunately this tends to beg the question. While it may be the case that people can use the media provided to perform a cooperative task, it may also be that people will not willingly use the media. For example, Galegher and Kraut (1992) performed a study in which a number of media tools were provided. These included e-mail, telephone, computer conferencing, and FTF meetings. There were three conditions: in the first condition participants were allowed only the computer conferencing and e-mail. The second group of participants were able to use the computer conferencing, email, and the telephone. The third group of participants were allowed to use all of the media plus FTF. The study showed that people often opted for the media that provided the richest communication medium even when a less rich one would have sufficed. It seems that a more appropriate question to ask may be, “will people use the tools provided?” That is, under what conditions will people continue to use the tools?

A measure of willingness to use the media tools may be that of satisfaction (Dicks, 1992). The assumption is that satisfaction with a particular media tool will have an effect on future use of that tool. If one is talking about an instructional context then satisfaction may also provide a measure of the likelihood that learning has taken place. That is, if people are dissatisfied with an instructional sequence they are less likely to be open to learning. Of course an openness to learning does not imply that learning will take place, only that the receptivity on the part of the student is increased. Some learning theorists have gone so far as to say that measures of satisfaction should come before outcome measures (e.g., Kirkpatrick,1990). Before one can reasonably evaluate outcomes the climate for learning should be maximized. Satisfaction provides an indication that an appropriate climate has been achieved. If people are satisfied with a cooperative learning experience they are more likely to have learned from it and are more likely to repeat such experiences.

Development of the Satisfaction Survey

Even though satisfaction may be the best measure of success, there are a number of things that may contribute to a participant’s satisfaction in addition to any experimental treatment (Bailey & Pearson, 1983). For example, an instructional designer may construct an instructional sequence for a distance-based cooperative learning experience. The degree of participant satisfaction with this instructional sequence may be influenced by factors other than the instructional sequence. Students bring, for example, past experiences into a learning experience. These experiences may range from past group work to previous experience with a computer. In general it has been suggested that attitudes and past experience may play roles in a student's satisfaction with a learning experience (Biner, 1993; Mitra, 1997; Kay, 1989;Hiltz & Johnson, 1990).

Personal Factors Contributing to Satisfaction

Biner (1993) and Mitra (1997) have suggested that a user's attitude toward computers may influence satisfaction with computer-based tools, for example computer-based communication media. Hiltz and Johnson (1990) identified a number of predictors including attitude and prior experience. As well they found anticipated usefulness a helpful predictor. For the purposes of this study these two general predictors, attitude and experience, were further defined to include attitude towards computers, group work, and computer mediated communication (e.g., email and newsgroups). Experience was similarly defined as experience with computers, group projects, and computer mediated communication. These constituted a set of predictor variables that could be classified as personal or individual variables.

Satisfaction Constructs

Biner, Dean and Mellinger (1994) identified seven factors of satisfaction with televised college level courses. Fulford & Zhang (1993) looked at students perception of the interaction with each other via interactive television. Hiltz and Johnson (1990) found four main factors of satisfaction: satisfaction with the computer program interface (interface), the relative ease or difficulty of using the program to do things they wished to do (mode), perceptions of others (unexpressive), and performance. From these studies a set of satisfaction constructs were suggested. These included satisfaction with the software, performance, group work, and perceived level of interaction.

Summary

The personal variables suggested included attitude and experience dimensions. Satisfaction dimensions ranged from satisfaction with group projects to satisfaction with performance. When the experimental variable was included, the predictors numbered seven (2 dimensions of personal variables along 3 scales plus the experimental variable). A characterization is shown in figure 4.

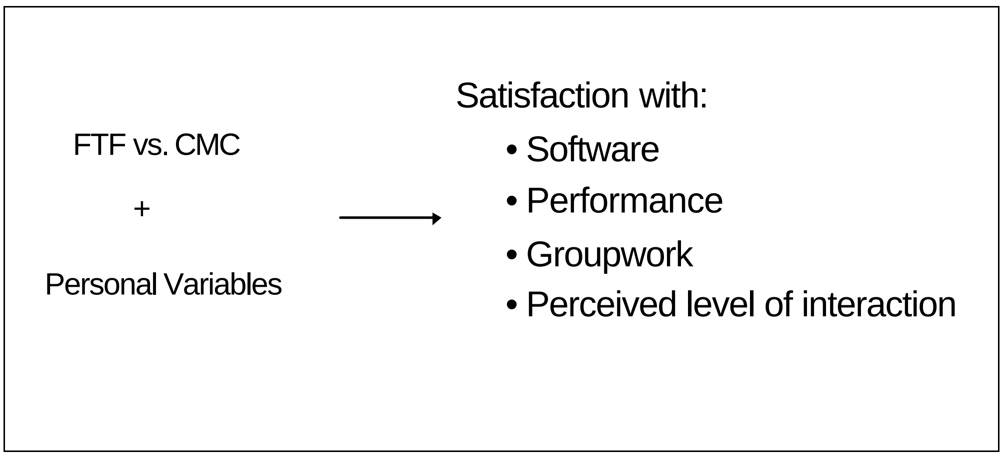

Figure 4: Characterization of personal variables, experimental variable, and their influence on satisfaction variables

Study Design

It has been shown that instructional design is an important factor in the construction of instructional sequences for distance-based learning. It has also been suggested that technology is now making it possible to include group projects as part of an instructional designer's toolkit. Daft & Lengel's communications model has been adopted and the means to evaluate its success have been elucidated. The next step was to begin operationalizing the various parts necessary to test the model. In particular that meant generating a testable research hypothesis.

The Research Hypothesis

If one accepts that the task-stages are correct, then it may be possible to vary the instructional design of a sequence at a particular task-stage. The first task-stage, for example, is characterized by much higher communications requirements than any of the other task-stages (see Figure 3). By varying task-stage 1 and holding other task-stages constant, in terms of communication flow, it is possible to test the model and determine if the instructional sequence may be successfully determined from the model.

Thus a primary research question was generated,

> "*Will varying communication modes between audio and FTF during the first phase of a cooperative learning task, while maintaining audio/graphic only modes for the rest of the task, produce measurable differences in participant satisfaction?*"

Although a question may be generated in which one design is favoured over another, the exploratory nature of this study suggests a more conservative approach. Thus no direction was suggested by the research question. Rather it was suggested that there would be a difference between the two instructional designs and that the difference will provide evidence as to which sequence is more appropriate for the task-type.

Since the primary research question was based on the idea of task-stages, it made sense to verify that the task stages were, in fact, present. Thus a secondary research question was also generated,

> *"Will participants interact in patterns similar to those suggested by the task-stages described by a Jigsaw I cooperative task?"*

Of general benefit to instructional designers was the development of a model to assist in the design of distance-based group projects. The model could, of course, benefit from more fine tuning to accommodate a wider range of use. Similarly more study would help to determine, with a higher degree of accuracy, where particular group projects, or phases of group projects, may fall on the model.

Theory and experience may be integrated into a distance-group-communications model that will help to design distance learning situations for various cooperative learning tasks. Satisfaction provides an appropriate evaluation variable for the model. It should be noted that this model makes no direct claim as to learning performance or quality-of-interaction variables. Rather the claim is that the model will help increase motivation by increasing satisfaction with the group learning experience. The measurement tool used in this study should help to isolate which variables contribute to which satisfaction outcomes and provide an indication of the degree to which they contribute. Due to the nature of the measurement tool's construction, the variables are isolated by virtue of theory and past research, the power of the tool may not be as strong as one would hope. Nevertheless, the results of this study should provide an indication of both the appropriateness of the model and of the efficacy of the measurement tool.

Chapter 4: Methods

Two research questions were generated from the discussion in chapters 2 and 3. The first or primary research question focussed on the applied use of a communications model adapted for use by instructional designers. To test the model, two instructional designs were generated. Analysis of satisfaction levels between the two designs was hoped to provide insight regarding where best to place task-stages on the model.

The primary research question was,

> "*Will varying communication modes between audio and FTF during the first phase of a cooperative learning task, while maintaining audio/graphic only modes for the rest of the task, produce measurable differences in participant satisfaction?*"

It was also desirable to verify that task-stages existed and existed as described. To verify the stages one must know what typifies each stage and activities go on in a particular stage. If the task-stages are accurate then whatever typifies each stage should be present as each group progresses through the study. For example, if the first task-stage is typified by questions about the task (how to proceed, who does what, etc.) and the second stage is typified by requests for verification ("is this what we decided?", "is this right?"), then we should find these types of questions being asked by the majority of study participants as they pass through each task-stage. These generated a secondary research question,

> *"Will participants interact in patterns similar to those suggested by the task-stages described by a Jigsaw I cooperative task?"*

Participants:

Eighty participants were selected from the campus population at the University of Calgary. Of these, 16 participated in the pilot study and the remaining 64 participated in the main study. Participants were recruited primarily from the departments of psychology and education. The psychology students who participated were contacted through the psychology volunteer student pool. This pool consists of first and second year psychology students. All other participants were solicited from classroom requests or from posters requesting participants. Participants were randomly placed into one of the two experimental conditions. Eighteen groups of three were formed. Nine groups were assigned to the CMC condition and nine groups were assigned to the FTF condition for a total of 54 participants. Another 10 participants formed 5 groups of 2. These groups were the result of 2 out of 3 participants showing up for a session and the participants were unable to reschedule. The data from these were only used for the pre-test measures.

Materials:

The Questionnaire

A two-part questionnaire was developed primarily from items found in prior studies. The first part contained the predictor items and the second part contained the criterion measures. When necessary the items were modified to conform to the current study, providing such modifications would not change the meaning of the item. In cases where there were no available items, new ones were constructed.

Item construction was conducted according to suggestions from both Kline (1986) and Palys (1992). A 7 point Likert-like scale was used. The rationale for using a 7 point scale stemmed from questionnaire testing. Initially a 5 point scale was used and a simulated factor analysis was conducted using mocked-up data. It was determined from this simulation that a 7 point scale was more likely to provide adequate variance for analysis. Item scales varied from, for example, “very frequently - never” to “strongly disagree - strongly agree”. The positive loading was, in some cases on the right end of the scale, while in others it was on the left end of the scale. It was hoped this would prevent participants from simply checking down one column without paying attention to the content of the items. In addition several items were reverse-coded so that the most likely response was opposite to that of any surrounding items. This was also expected to prevent participants from making automatic responses. Together the two methods helped to determine when surveys were being erroneously responded to, whether intentionally or otherwise.

Part one of the questionnaire contained items relating to attitude and experience along the dimensions of computer use, group projects, and computer-mediated-communication. In all there were 26 items of which 15 items were attitude items (5 each for computers, group projects, and computer-mediated-communication) and 11 were experience items (4 computer, 4 CMC, and 3 groupwork). Items were adapted from surveys used in the measurement of attitudes and experience related to computer use (Evans & Jarvis, 1986; Kay, 1989; Mitra, 1997; Popovich, Hyde, Zakrajsek & Blumer, 1987; Richards, Johnson, & Johnson, 1986; Schlough, 1997;) (see Appendix B, Part 1).

Part two of the questionnaire contained criterion items to measure satisfaction with group projects, perceived interaction, performance, and the software. As before, items were adapted from surveys used in the measurement of satisfaction (Biner, Dean, & Mellinger, 1994; Biner, 1993; Fulford & Zhang, 1993; Bailey & Pearson, 1983; Hiltz & Johnson, 1990). These resulted in 19 items (see Appendix B, Part 2).

In addition a set of demographic items were constructed. The items of interest included the number of hours spent using a computer, levels of computer expertise, and past experience with group projects. These were expected to supplement experience items from part 1 of the questionnaire. The complete questionnaire may be found in Appendix B, Part 1.

Protocol Analysis

Protocol analysis is particularly suited to observational data. According to Palys (1992), observational data gathering can range from a very structured protocol to anecdotal reporting. In a structured protocol observers first agree on what counts as data (the protocol) and then independently record the data. If the protocol is accurate then each set of independent observations based on the protocol should be very nearly the same. Despite the higher accuracy of two or more independent observers, logistics dictated a single observer for this study.

The task-stages proposed in the communications model suggest an observational protocol based on the types of activities typically found in each task-stage. By counting the number of times participants ask or talk about something, and by categorizing each exchange, we can determine if the groups in this study are passing through task-stages similar to the stages suggested. A protocol was developed that included counting the number of times participants said anything. Each time a participant spoke, it was counted as an utterance. However, non-linguistic utterances or general noise was not counted. For example, a phrase such as “hmmm” or “sigh” was not counted. Each time a series of utterances occurred that involved at least two participants, it was deemed an exchange. Exchanges were recorded and later categorized by their content. Exchanges were categorized according to the type of activity and the focus of the content. Table 6 shows a subset of the typical exchanges that were expected to be found arranged by task-stage.

Table 6: Types of Exchange and Exchange Rates in Different Task-Stages

Task Stage	Exchange Rate	Exchange Type
Stage 1	High	Task Related: What are we supposed to do? Who should do what? Software Related: How do I get a postit? How do I move it?
Stage 2	Low	Task Related: Was I doing the sports? Who is doing entertainment? Non-Task Related: Did you see Seinfeld on TV? How about the weather?
Stage 3	Low-Medium	Task-Related: Have a look at this … Do I have enough here?
Stage 4	Medium-High	Task-Related: Can you edit this for me? How about this kind of layout? Can you move your postit over here? Are we finished?

Audio and video data were recorded for subsequent analysis using this protocol. Software was developed to help record the total number of utterances during a group project.

Task Description

Although it was hoped that the findings of this study would generalize across populations (e.g., K-12, post-secondary), the most available population were post-secondary students. The reason was, in large part, due to the interests of the researcher and a convenience sample. That is, a post-secondary student population was more accessible than a K-12 population. A consequence of that decision was that the task used for the study had to be relevant to a post-secondary population. The caveat was that the task had to provide for sufficient interaction between participants. It had to have a good chance of generating differences between instructional designs if, in fact, there were any differences to be found.

There are a number of different techniques for implementing cooperative learning strategies. Among these are the Jigsaw I (Mattingly & VanSickle, 1991) and Jigsaw II (Slavin, 1983). There are, of course, other permutations but these represent the better known and relevant techniques. Essentially these techniques take a task and break it into pieces. Each piece is then given to a group member. The work of each member contributes to a group whole. Studies using the Jigsaw I technique often use a methodology whereby each group member becomes an expert in a particular area and then shares that expertise with the rest of the group. A deliverable would be an essay.

Most post-secondary group project tasks are constructed so that groups may determine their own topic areas and divide the work between each of the group members. Group members must integrate the contributions of each group member in some way. Quite often this involves assembling a product (e.g., an essay). It may also involve assembling physical pieces such as parts of a program, parts of a multimedia project, or parts of a research study. Because of the similarities, it was suggested that the Jigsaw technique best approximates most post-secondary group project tasks.

Task descriptions were generated for each of two instructional designs based on a Jigsaw I technique (see Appendix A). That is, instructional designs were developed that varied the communications mode at task-stage 1. These were subsequently mapped onto the communications model (see Figure 5).

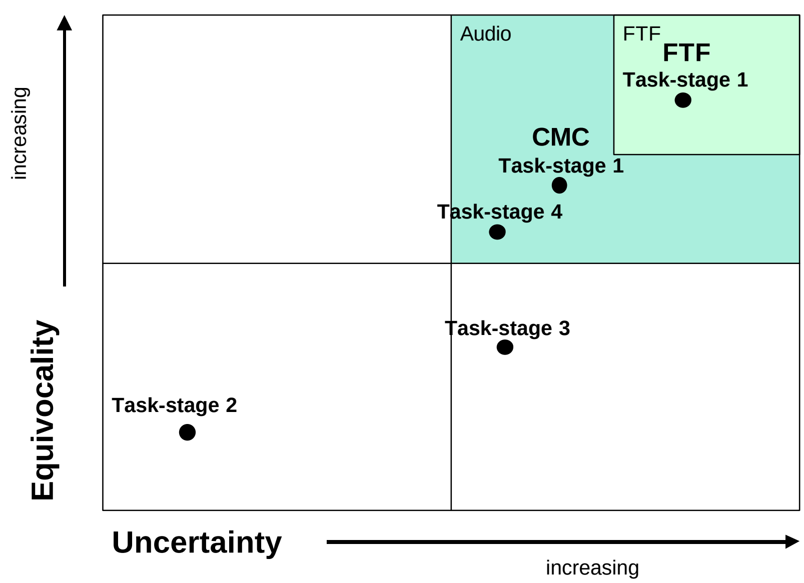

Figure 5: Jigsaw task stages mapped onto the model.

Notice that the FTF and the CMC task-stage 1 markers are in the FTF and Audio stages, respectively.

Software Support Required

In order to determine the appropriate hardware and software configuration for the task it was first necessary to delineate the interaction modes that needed to be supported in accordance with the task description.

From Table 5 it was possible to get a feel for the task dynamics and the types of interactions that were likely to occur given the task description. For example, group members were expected to talk to each other about the task parameters and task allocation during task-stage 1. During task-stage 4 participants were expected to discuss the completeness of the project and perform any final layout sub-tasks. During any given stage it was expected that group members were likely to be speaking to the group. Likewise any single group member expected to hear all that was going on. This type of communication has been called many-to-many interaction. Other types are one-to-one (one person talking exclusively to one other person) and one-to-many (as in a lecture, the instructor talks to many students).

A second type of interaction that was likely to occur was interaction with the material. The newspaper summaries needed to be viewable by the group and later reorganized by the group when doing the final layout. When groups are working face-to-face it is easy to show an article or clipping to the other group members simply by holding the clipping up to the group. Later when editing the summary page all the clippings may be placed on a table and everyone can simply reach over and move the clipping they want to move *while* the remaining group members watch. Groupware was required that would support this type and level of interaction.

A program named TeamWave, which was developed in the GroupLab in the Department of Computer Science at the University of Calgary, provided the kinds of group interaction needed for this study (Roseman & Greenberg, 1997). Teamwave also met platform and cost requirements (it was free for educational/research use). Figure 6 shows the initial screen configuration of Teamwave as group participants first saw it.

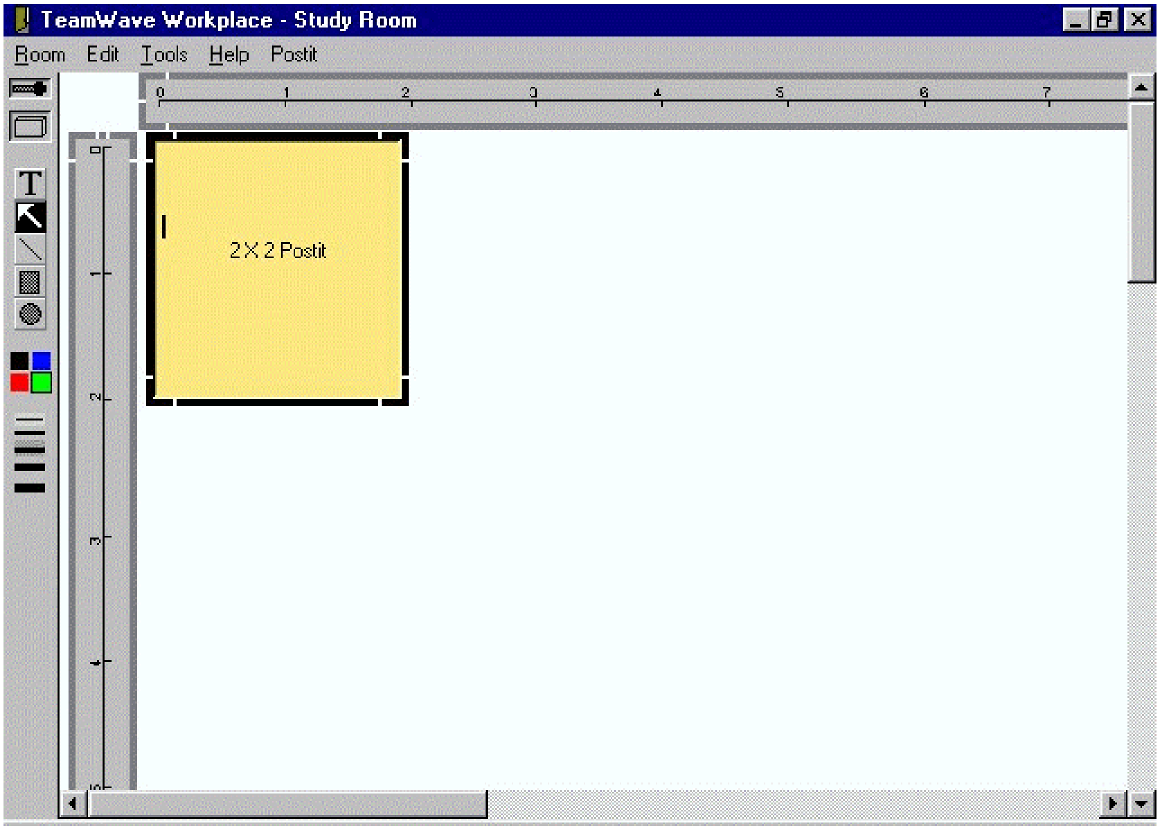

Figure 6: The user interface.

The rulers on the top and left demarcated an editing space of 8” by 8”. Groups were required to constrain their final newsletter to those measurements. The toolbar on the left was not introduced to the participants as none of the tools were directly related to the task. Participants were only shown how to make, use, and delete postit tools[3].

Additional Materials

A number of copies of the Calgary Herald were purchased. These same copies were used throughout the study. Thus all participants saw the same edition regardless of at what point during the study they participated. It should be noted that when one copy became too marked up or destroyed, it was replaced with a "new" copy.

Procedure:

The group project task description involved the construction of a newsletter by employees of an overseas branch of a Calgary-based company (see Appendix A). The task was constructed so that employees were required to use groupware to construct the newsletter. The experimental manipulation for task-stage one involved two conditions: the CMC condition and the FTF condition. In the CMC condition participants performed the entire task in separate rooms using only the groupware provided. The groupware included a shared whiteboard (for construction and layout of the newsletter) and many-to-many, full duplex audio. This meant that they could work on the newsletter and talk to each other at the same time (what one did or said, the other two saw or heard). The FTF condition differed in that participants were able to meet FTF for up to 20 minutes to determine the task parameters prior to beginning the construction of the

[3] The postit tool was so named in the Teamwave program. Despite possible trademark conflicts, the term postit will be used throughout this paper to refer to the Teamwave tool, not the Post-It notes made by 3-M Company.

newsletter. This corresponded to the kinds of activity typical of task stage 1. All participants completed task-stages 2 to 4 in the same fashion (e.g., using CMC).

The optimum groupware mix was mediated by the task description and by cost and availability of hardware/software. A program named Teamwave Workplace 2.2 provided a shared whiteboard as well as a number of other shared objects. The most useful of these objects were postit notes. These provided a way for participants to add and delete articles as well as move them around with a minimum of difficulty or training. Once a postit was added, any and all participants could add information (articles) to the postits, move them around, or even delete them. Full duplex, or many-to-many, audio was provided by using a mixing board, microphones and headphones. Audio was provided to each room (see Figure 7).

Four rooms were used. One room was used as an initial meeting room and for the FTF condition. Three other rooms were each equipped with a computer workstation and these workstations networked to a server. Each room was separated by an empty hall or by an empty room. Thus the likelihood of participants hearing each other through the walls, although possible, was minimized. Lastly video recording equipment was installed in one of the workstation rooms and the screen was recorded along with the audio component of the conversation (all 3 audio components were fed into the VCR).

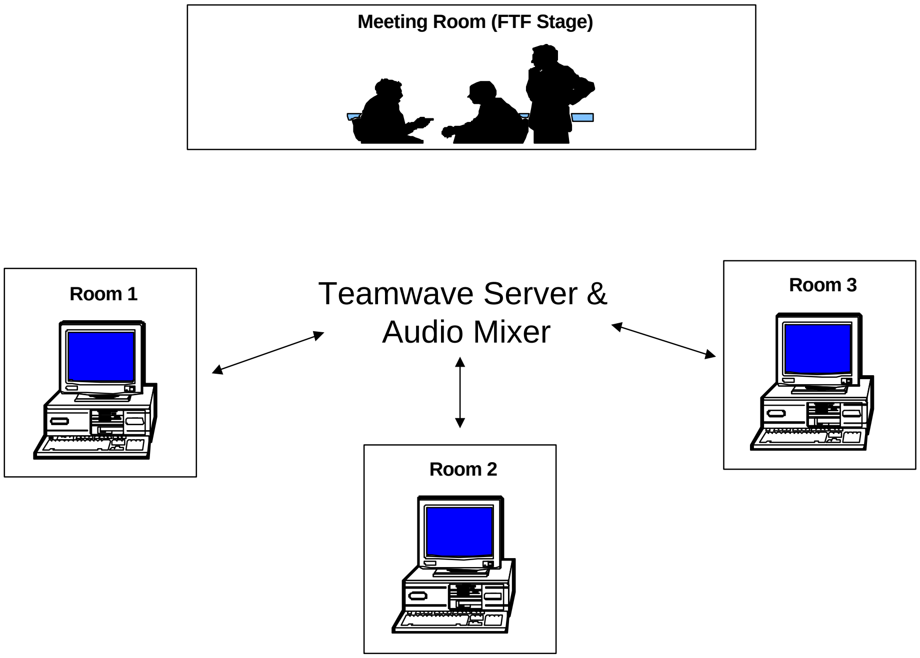

Figure 7: The three participants were able to communicate using both computer and audio. Each participant was physically separated from the others

Participants were semi-randomly placed in groups of three. The constraints were whether or not three participants could meet on the same day at the same time. Groups were provided with consent forms and then the activities they would be performing during the experimental session were explained in more detail. Each group completed part 1 of the questionnaire in the main meeting room. Groups were then provided with the appropriate task description for the experimental condition they were in (FTF or CMC condition). The FTF groups remained in the same room and completed task-stage 1. The dialogue from the FTF sessions was audio taped for later analysis. Both CMC and FTF groups were instructed on the use of the computer and the software prior to beginning the next task-stage (task-stage 1 for CMC groups, task-stage 2 for FTF groups). The CMC component was video and audio taped for later analysis. The video data was obtained from an angle that included only the monitor from one participant. It was not deemed important to “see” the participants, only the results of their actions and interactions. Each group was given as much time as was needed to complete the task. After the task was completed, participants returned to the main meeting room and completed part 2 of the questionnaire. A debriefing session ensued. Participants were paid $5 and thanked for their participation. See Appendix D for a detailed description of the protocol used in this study.

Chapter 5: Results

Measures collected during this study included questionnaire and demographic data as well as audio and video records. The demographic data was analyzed using descriptive statistical methods. The questionnaire items were grouped into a smaller set of components using factor analysis. A stepwise regression was applied to the components. The audio-video data was analyzed using protocol analysis. Finally, based on anecdotal observations, a post-hoc analysis of group by gender effects was conducted.

Procedures

A pilot study was conducted to determine the optimum experimental setup and procedures. Sixteen participants took part in the pilot phase, insufficient for statistical analysis. However, a refinement of the procedures, technical setup, and task elements was achieved.

Following the pilot phase the main study phase was conducted. While the number of members per group was set at three, on occasions only two participants arrived for a session. When the experimenter felt the participants would not be amenable to rescheduling, the session was conducted with two participants. This resulted in 23 groups of which only 18 contained 3 members. Only the data from the 18 groups of 3 members were used for analysis. The exception to this rule was during the analysis of the predictor variable data. The pooling of data for the predictor variable analysis was based on the assumption that since no treatment had been administered, all pre-treatment items reflected baseline data.

Demographics

Participants in this study ranged in age from 18 to 53 years with a median age of 21 years (m = 23.63, SD = 8.0). Nearly 75% of the participants were between the ages of 18 and 23. Group composition was a function of convenience due to recruitment and scheduling constraints.

The gender composition of groups is described in Table 7. Half the groups consisted of two female and one male participant.

Table 7: Group - gender composition.

Gender Composition	Frequency	
	Groups	Participants
3 Female, 0 Male	4	12
2 Female, 1 Male	9	27
1 Female, 2 Male	5	15
Total	**18**	**54**

Participants were from a variety of disciplines (see Appendix F). The Psychology Department student pool was the primary source of participants. Consequently, the bulk of the participants were from the department of psychology (42%).

The number of years of post-secondary education ranged from 1 to 8 years with approximately 64% currently in years 1, 2 or 3. Only 10.9% (7) participants had *never* worked on group projects before (see Table 8). Although an analysis of the number of group projects by department was performed, no obvious relationship was found.

Table 8: Frequency of participants and group projects.		
# of Group Projects	Frequency (# of participants)	%
0	7	10.9
1	3	4.7
2	13	20.3
3	8	12.5
4	4	6.3
5	5	7.8
6	8	12.5
7	4	6.3
8	4	6.3
9	2	3.1
10	2	3.1
11	1	1.6
12	3	4.7
Total	64	100.0

Computer usage measures indicated that 59.5% of the participants used their computers frequently with a median value of 5.5 hours per week. Nearly all the participants, except for 3, owned their own computer. Although, it was suggested that computer use would correlate with particular areas of study, computer science for example, no such relationship was found. Given the ubiquity of computer use by participants, the interface used in this study was not considered an impediment to manipulating the groupware.

Data Analysis - Questionnaire Data

The data analyses for the questionnaire data were carried out in several stages. A factor analysis was first performed on the predictor and criterion variables. A regression analysis was computed to help determine the relationship between predictor and criterion variables.

Factor Analysis – Predictor Variables

A factor analysis was performed on the 26 predictor variable items to repackage the variance into a small set of components. Factor analysis is used to group related questionnaire items into components. These components are assumed to represent or measure a construct. However, factor analysis makes no claim as to the meaning of the components. Components are interpreted by the experimenter. A principle components extraction method was chosen because of its ability to maximize the variance accounted for by each component (Gorsuch, 1983). The criteria used for grouping the items into components was an eigen-value of 1.0. A varimax rotation was performed to obtain the most parsimonious set of components. A varimax rotation is based on the assumption that components are not correlated with each other (orthogonal). When components are thought to be correlated, an oblique rotation is used. The strength of the relationship or component membership for any questionnaire item was indicated by its factor loading. A higher loading value indicated that an item was strongly related to the component, and to the other items in the component. Although a factor loading of .30 would have been sufficient (Kline, 1986), a more stringent factor loading of .50 or higher was used to reflect the exploratory nature of this study and the small number of participants. Seven components were extracted and labels were assigned to each component based on the content of the items loading on the component (see Table 9).

Twenty-four of the 26 items had loadings of .50 or greater resulting in a seven factor solution. These seven factors accounted for 68.9% of the total variance of the predictor variables. A reliability analysis was performed with the resulting Alpha coefficient shown in Table 9. An alpha coefficient of .70 or better is considered reliable (Kline, 1986). The alpha coefficients were generally high indicating good reliability for each component.

Table 9: Predictor Variable factor loadings.

	Attitude towards groupwork	Attitude towards computers	Experience / Attitude towards CMC	Experience with groups	Anxiety/ Prefer FTF	Instructors and Email	Experience with DB, SS, and on-line
1.	.890						
2.	.850						
3.	.785						
4.	.768						
5.	.685						
6.	.600			.528			
1.		.822					
2.		.818					
3.		.713					
4.		.653					
5.		.619					
1.			.802				
2.			.771				
3.			.524				
1.				.624			
2.				.608			
3.				.517			
1.					.854		
2.					.836		
1.						.818	
2.						.739	
1.							.745
2.							.670
3.							.527

The components shown in Table 9 are described in more detail in Tables 10a through 10g. In particular, the wording of the items associated with a component and the semantic differential used by the item is shown. The semantic differential for all items was 1 to 7. The mean and standard deviation are included to provide a sense of how participants responded to individual items. A higher mean is interpreted according to the semantic differential. For example, the semantic differential is Never – Very Frequently (obviously a usage item), then a mean of 5.0 would indicate higher use than would a mean of 2.0. The factor loadings for each item are repeated from Table 9. It should be noted that a higher factor loading indicates a stronger relationship with the other items in the component.

Table 10a. Attitudes and Experience with Groupwork

	Content	Semantic Differential	mean	s.d.	Factor Loading
1.	In my experience group projects have worked out well …	Very frequently – Never	4.79	1.43	.890
2.	My experience with group projects has been positive.	Strongly disagree – Strongly agree	5.03	1.51	.850
3.	Group projects have been beneficial to me.	Strongly disagree – Strongly agree	5.22	1.27	.785
4.	Whenever I have worked in a group project the result has been better than I could have done on my own.	Strongly disagree – Strongly agree	4.25	1.59	.768
5.	I look forward to group projects.	Strongly disagree – Strongly agree	4.22	1.82	.685
6.	I participate in group projects …	Very frequently – Never	4.43	1.69	.600
		Component Mean	4.65		

Variance Accounted for by this Component: 16.62 % Alpha Coefficient: .8706

Also, the amount of variance that a component accounted for is shown. If a component accounted for 10% of the total variance of the entire set of items, then the variance accounted for is 10%. Such information helps to determine the importance of the component. If, for example, a component accounted for 2% of the total variance of the set of items, it may not be considered as important as a component that accounts for 10% of the total variance. Finally, the alpha coefficient for the component is included to help gauge the reliability of the component. The items that comprised the component "*Attitudes and Experience with Groupwork"* was expected to load on two components, namely "attitude towards groupwork" and "Experience with Groupwork". It appeared that the participants focussed on the keyword, "group". The strength of the component, particularly the high factor loadings, the reliability coefficient, and the amount of variance accounted for, suggest that the perception of groupwork was an important factor.

10b. Attitude and Experience with Computers

	Content	Semantic Differential	mean	s.d.	Factor Loading
1.	I use a computer …	Never - Very frequently	5.07	1.65	.822
2.	I would rate myself as a computer expert.	Strongly disagree – Strongly agree	3.11	1.57	.818
3.	I am comfortable using a computer.	Strongly disagree – Strongly agree	5.45	1.37	.713
4.	I would prefer to do as much of my work on a computer as possible.	Strongly disagree – Strongly agree	4.08	1.72	.653
5.	I have a good understanding of how computers work.	Strongly disagree – Strongly agree	4.75	1.43	.619
		Component Mean	4.49		

Variance Accounted for by this Component: 14.70 % Alpha Coefficient: .8433

As with the previous component, it was expected that two components would be derived. However, it appeared that the keyword "computer" was the grouping variable for this component rather than experience or attitude. Nevertheless, this was a strong component.

10c. Use and Attitude Towards CMC

	Content	Semantic Differential	mean	s.d.	Factor Loading
1.	I participate in chat sessions …	Never - Very frequently	1.09	1.47	.802
2.	Chat groups provide a unique way to communicate with others.	Strongly disagree – Strongly agree	1.70	1.32	.771
3.	I participate in newsgroup discussions …	Never - Very frequently	0.70	.92	.524
		Component Mean	1.17		

Variance Accounted for by this Component: 7.954 % Alpha Coefficient: .6488

The component “Use and Attitude towards CMC” was another hybrid component that may have reflected a lack of experience with more sophisticated groupware. The item means suggested that low usage patterns may have contributed to generally negative attitudes towards chat groups. It should be noted that the reliability or alpha coefficient was .6488, below the .70 level generally considered high enough to indicate reliability. A consequence of lower reliability levels may be that the composition of the component may change with a different population, or may change with more participants.

10d. Group Experience

	Content	Semantic Differential	mean	s.d.	Factor Loading
1.	The courses I have taken thus far have involved group projects …	Never - Very frequently	4.37	1.70	.624
2.	I am confident I can learn any computer program.	Strongly disagree – Strongly agree	5.33	1.46	.608
3.	Arranging meeting times with group members has never been a problem.	Strongly disagree – Strongly agree	3.02	1.85	.517
		Component Mean	4.24		

Variance Accounted for by this Component: 7.779 % Alpha Coefficient: .3135

The alpha coefficient for the component "Group Experience" was extremely low (alpha = .3135) suggesting this component was unreliable. The component items may load differently with a different population or more participants.

10e. Anxiety/Preference for FTF.

	Content	Semantic Differential	mean	s.d.	Factor Loading
1.	I would rather communicate with someone face to face than by telephone.	Strongly disagree – Strongly agree	5.66	1.45	.854
2.	I would rather communicate with someone face to face than by computer.	Strongly disagree – Strongly agree	5.61	1.35	.836
		Component Mean	5.64		

Variance Accounted for by this Component: 7.609 % Alpha Coefficient: .8049

The component "Anxiety/Preference for FTF" consisted of only two items, and appeared to be grouped on the keywords "face-to-face". The component mean suggested participants agreed with the items showing a preference for FTF over communication by telephone or computer. However, the items were worded similarly to items used in a computer anxiety study (King, Henderson, & Putt, 1996). These items compared FTF to using the web or using email. The semantic differentials were the same. Thus a second interpretation of this component was that it was an indication of anxiety. Both interpretations are explored further in Chapter 6.

10f. Instructors and E-Mail

	Content	Semantic Differential	mean	s.d.	Factor Loading
1.	If I could communicate with my instructor by email I would.	Strongly disagree – Strongly agree	5.19	1.61	.819
2.	More instructors should make themselves available by email.	Strongly disagree – Strongly agree	5.69	1.41	.739
		Component Mean	5.44		

Variance Accounted for by this Component: 7.277 % Alpha Coefficient: .6575

The label for the component “Instructors and E-Mail” reflect the keywords of the two items that comprise it. The component indicates a generally positive attitude towards using e-mail as a means of communication with instructors. However, it should be noted that the reliability coefficient was slightly below 0.70 at .6575.

10g. Experience with DB, SS, and On-Line

	Content	Semantic Differential	mean	s.d.	Factor Loading
1.	I use database programs …	Never - Very frequently	1.77	1.33	.745
2.	I have participated in on-line group tasks …	Never - Very frequently	0.59	1.22	.670
3.	I use spreadsheet programs ...	Never - Very frequently	1.77	1.60	.527
		Component Mean	1.38		

Variance Accounted for by this Component: 6.984 % Alpha Coefficient: .5637

The final component, "Experience with DB, SS, and On-Line", appeared to reflect a low usage pattern for non-mainstream software. That is, the mean for the component was 1.38 reflecting a semantic meaning of "almost never" while the mean for the item "I use wordprocessors …" was 4.80 reflecting a semantic meaning of "fairly often". This makes sense if one considers that most post-secondary courses require essays to be wordprocessed while there is no such compunction to use database or spreadsheet programs. It is suggested that the third item, participation in group tasks, grouped with the productivity software items simply because it was also little used. Perhaps by virtue of the diversity of the items, this component had lower factor loadings than other components and showed a reliability coefficient of only .5637.

Factor Analysis – Criterion Variables

A factor analysis was performed on the 18 criterion variables and a principal components analysis was performed with the extraction criteria set to an Eigen value of 1.0. Because the factors were assumed to be orthogonal a varimax rotation was performed. Items were assumed to load on a factor if the loadings were .50 or above (see Table 11).

Table 11: Criterion Variable Factor Loadings.

	Satisfaction with group and task	Satisfaction with the Software (performance, interface, mode)	Satisfaction with the interaction	Satisfaction with the mode (m), and unexpressive (u)	Satisfaction with information flow	Made a personal connection with group members
1.	.903					
2.	.838					
3.	.833					
4.	.750					
5.	.744					
6.	.596					
1.		.869				
2.		.858				
3.		.724				
4.		.659				
5.		.639			.525	
6.		.552				
1.			.941			
2.			.936			
1.				.837		
2.				.804		
1.					.919	
1.						.751
2.						.711

Eighteen items with factor loadings of .50 or greater accounted for six components. These six components accounted for 72.0% of the total variance of the 18 variables. The components shown in Table 11 are described in more detail in Tables 12a through 12f. It should be noted that the items were drawn from studies on satisfaction. The component labels are in keeping with the sources of the items. That is, the component labels are prefixed by “Satisfaction with” as were the source items.

12a. Satisfaction with Group and Task

	Content	Semantic Differential	mean	s.d.	Factor Loading
1.	This was a positive group experience.	Strongly disagree – Strongly agree	6.28	1.09	.903
2.	Communications tools such as those used in this study could improve group experiences.	Strongly disagree – Strongly agree	5.81	1.30	.838
3.	I enjoyed doing the task.	Strongly disagree – Strongly agree	6.07	1.23	.833
4.	The task we performed was easy.	Strongly disagree – Strongly agree	5.67	1.43	.750
5.	I would like to do more group work using computers.	Strongly disagree – Strongly agree	5.43	1.19	.744
6.	Doing well in this task was important to me.	Strongly disagree – Strongly agree	5.57	1.02	.596
		Component Mean	5.80		

Variance Accounted for by this Component: 23.4% Alpha Coefficient: .8774

The component “Satisfaction with Group and Task” accounted for a large amount of variance (23%) and was shown to be reliable (alpha coefficient = .8774). The items that comprised the component used keywords such as group and task. It was likely that participants associated the task with groupwork. Thus the component was probably a reflection of their satisfaction with this particular combination of task description and a group approach to the completion of the task. It may be that a different task description or a different set of group constraints may produce differing levels of satisfaction. However, that is precisely what would be expected to happen if this component truly did reflect "Satisfaction with Group and Task."

12b. Satisfaction with the Software

	Content	Semantic Differential	mean (group)	s.d.	Factor Loading
1.	Please indicate your reactions to the software used in this study.	Time wasting – Time saving	5.57	1.19	.869
2.	Please indicate your reactions to the software used in this study.	Unproductive - Productive	6.09	.94	.858
3.	Please indicate your reactions to the software used in this study.	Frustrating – Not frustrating	5.50	1.60	.724
4.	Please indicate your reactions to the software used in this study.	Impersonal - Friendly	5.67	1.23	.659
5.	How frequently did you feel held back by the computer system?	Always – Never	5.37	1.32	.639
6.	Please indicate your reactions to the software used in this study.	Hard to learn – Easy to learn	6.55	.69	.552
		Component Mean	5.79		

Variance Accounted for by this Component: 17.4 % Alpha Coefficient: .8187

The software used in this study consisted of Windows 95 and Teamwave Workplace. Thus the interpretation of the component "Satisfaction with the Software" must be considered in that light. That is, the levels of satisfaction may change given different software. Although the factor loadings for items varied substantially from .552 to .869, the reliability coefficient was quite high (alpha = .8187). Together this suggests the component may be useful to help measure contributions to satisfaction due to the software employed.

12c. Perceived interaction

	Content	Semantic Differential	mean	s.d.	Factor Loading
1.	The level of interaction between the participants was …	Very low – Very high	5.70	1.28	.941
2.	Overall the level of interaction was …	Very low – Very high	5.77	1.24	.936
		Component Mean	5.74		

Variance Accounted for by this Component: 10.6 % Alpha Coefficient: .9576

Fulford & Zhang (1993) found that items measuring “Levels of Interaction” loaded together and that the most meaningful item was often the one measuring overall interaction. Although perceptions of interaction between participants was found to be less stable in their study, perceptions of overall interaction proved much more stable. In the current study the items appeared highly correlated as indicated by the reliability coefficient and the factor loadings. The mean for the items indicated a slightly lower perception of the level of interaction between participants as compared to overall interaction.

12d. Satisfaction with Mode and Unexpressive

	Content	Semantic Differential	mean	s.d.	Factor Loading
1.	How often did you feel overloaded with information?	Never – Always	5.80	1.07	.837
2.	How often were you able to express your views using the computer system?	Never – Always	5.72	1.17	.804
		Component Scores	5.76		

Variance Accounted for by this Component 8.3 % Alpha Coefficient: .5749

Components “Group Experience” and “Anxiety/Prefer FTF” shared an item (“overloaded with information”). Otherwise, both were composed of only two items. The reliability coefficients were low in both cases (.5749 and .6274 respectively). It may be that a different participant population or more participants would have changed the composition of these components. It may be that the shared item was splitting variance that would otherwise have been combined in one component. That is, the two remaining items “able to express views” and “held back” were similar and were expected to load together.

12e. Satisfaction with Information Flow (note that item 1 of this component is shared with 12d).

	Content	Semantic Differential	mean	s.d.	Factor Loading
1.	How often did you feel overloaded with information?	Never - Always	5.67	1.15	.919
2.	How frequently did you feel held back in the types of contributions you could make?	Never - Always	5.37	1.32	.525
		Component Mean	5.52		

Variance Accounted for by this Component: 6.8 % Alpha Coefficient: .6274

12f. Impression of Personal Connection and Affiliation

	Content	Semantic Differential	mean	s.d.	Factor Loading
1.	How often did you get an impression of personal contact?	Never - Always	5.72	1.07	.751
2.	I would like to stay in touch with my fellow group members.	Strongly disagree – Strongly agree	5.22	1.35	.711
		Component Mean	5.47		

Variance Accounted for by this Component: 5.6 % Alpha Coefficient: .3764

The final satisfaction component, “Impression of Personal Connection and Affiliation” was perhaps the weakest component with an alpha coefficient of only .3764. As well, it was composed of only two items. Considering the low amount of variance that this component accounted for (5.6%), less weight should be placed on its ability to measure impressions of personal connection and affiliation.

Experimental Condition

A series of ANOVA analyses were performed on the criterion variables comparing the experimental conditions FTF and CMC (see Table 13).

Table 13: ANOVA results comparing experimental conditions across criterion variables.

Criterion Variable	**ANOVA Statistic**
Satisfaction with Group and Task	$F(1,52)=0.025$, $p<.874$
Satisfaction with the Software	$F(1,52)=1.973$, $p<.166$
Perceived Interaction	$F(1,52)=0.432$, $p<.514$
Impression of Personal Connection	$F(1,52)=0.000$, $p<1.0$
Satisfaction with Information Flow	$F(1,52)=0.112$, $p<.739$
Made a Personal Connection	$F(1,52)=0.005$, $p<.944$

The results indicated that the experimental condition had no significant effect on any of the criterion variables. However, it should be noted that the only variable to approach significance was Satisfaction with Software. In this case people preferred CMC to FTF although not significantly so.

The next section describes the use of regression analysis to determine the contribution of the predictor variables to levels of satisfaction in each of the criterion variables. The experimental condition was included in the analysis to help determine if there was any contribution to the criterion variables and whether there was any overlap or correlation between the experimental variable and any of the predictor variables.

Regression Analysis

A regression analysis was conducted to help determine the contribution of each of the predictor variables to each of the criterion variables. Regression analysis is a methodology which aims at determining how much of the total variance of a criterion variable can be accounted for by a set of predictor variables (Gorsuch, 1983). The individual contribution of each predictor variable is also indicated by the procedure.

It was determined that an alpha level of .10 would best capture the data and still be considered adequate for significance testing. This allowed a greater chance of seeing which components were related than would a more traditional value of .05. A stepwise regression methodology was adopted in which predictors are systematically added to the equation. A stepwise algorithm makes no assumptions about which components should be added to the equation first, second, and so on. Rather, components are added according to the amount of variance in the criterion variable each component can account for. The component that accounts for the largest variance is entered first. Components are added until they no longer account for a significant amount of variance, as measured by the alpha level (Pedhazur, 1982).

Four statistically significant regression equations were derived (see Tables 14a-14d). Each of the predictor variables is included along with how much variance in the criterion variable it was able to account for. This is indicated by the r^2 change column. The third column indicates the coefficient each variable takes in the equation. The coefficient is a weight assigned to a variable based on its ability to account for variance and its relation to the other variables in the equation. The total variance accounted for in the criterion variable by all of the predictor variables in the equation is included in the total at the bottom of the table. Notice that the Anxiety/Prefer FTF variable is present in all four equations.

14a. Satisfaction with Group and Task

Predictor Variable	R^2 Change	Coefficient (standardized)
Anxiety/Prefer FTF	.094	.375
Hours per week using a computer	.059	.252
Total Variance Accounted for p < .015	**.153**	

The correlation of the coefficients for the equation shown in Table 14a was .272. This indicated that the two predictor variables were somewhat related (Netter, Wasserman, & Netter, 1985). As can be seen, the Anxiety/Prefer FTF variable accounted for over 9% of the variance in the Satisfaction with Group and Task variable while the usage variable accounted for only 5.9%.

14b. Satisfaction with Software

Predictor Variable	R^2 Change	Coefficient (standardized)
Anxiety/Prefer FTF	.130	.390
Experimental Variable (FTF vs. CMC)	.057	.240
Total Variance Accounted for, p < .005	**.186**	

In the case of Satisfaction with Software, the correlation between the coefficients was .125 indicating a fairly high degree of orthogonality. Again, the Anxiety/Prefer FTF variable accounts for the largest amount of variance (13%). Note that this was the only equation in which the experimental variable was present.

14c. Perceived interaction

Predictor Variable	R^2 Change	Coefficient (standardized)
Use and Attitude Towards CMC	.093	.327
Anxiety/Prefer FTF	.085	.292
Total Variance Accounted for, p < .007	**.178**	

The third equation, Perceived interaction, showed Use and Attitude Towards CMC accounted for slightly more variance than Anxiety/Prefer FTF. The correlation between the coefficients was .078.

14d. Impression of Personal Connection and Affiliation

Predictor Variable	R^2 Change	Coefficient (standardized)
Anxiety/Prefer FTF	.070	- .341
Attitudes and Experience with Groupwork	.094	.354
Experience with DB, SS, and On-Line	.064	- .257
Total Variance Accounted for, p < .004	**.228**	

The final equation included three variables. The correlations between the coefficients ranged from -.20 to .065. Again, these indicated high degrees of orthogonality.

Group Composition

Anecdotal evidence gathered by the experimenter during the group sessions suggested that mixed gender groups interacted somewhat differently than all female groups (there were no all male groups in the study so no such comparative analysis was possible). That is, the interpersonal dynamics appeared to differ when one or more males were included in the group compared to all female groups. Although no prior evidence was obtained to support an analysis of group structure (e.g., prior studies), it was determined that at least a cursory analysis was in order. To determine if there were any effects due to group composition one-way anova's were performed where the group composition was the predictor variable. The criterion variable was one of the six component criterion variables (satisfaction variables). The results showed a significant difference on the criterion variable “Impression of Personal Connection and Affiliation “ ($F(2,51) = 3.866$, $p < .03$). Table 15 shows the group composition by gender and the mean score for the satisfaction component.

Table 15: Group Composition by Gender

Group Composition	**Component Mean**
3 Female, 0 Males	5.34
* 2 Female, 1 Male	5.78
* 1 Female, 2 Males	5.00

* Tukey HSD p < .05.

It appears from these results that group composition has an effect on how people perceive and make personal connections with other members of the group. In this case it appeared that participants were more likely to feel a personal connection had been made with another group member when the group composition was 2 female and one male. Conversely, the least likely composition to generate feelings of connectedness with other group members was when there was 1 female and 2 males.

The suggestion that group composition can make a difference in group outcomes along certain measures, bears out anecdotal evidence during the course of the study. That is, the interaction between group members appeared to be somewhat different depending upon whether or not there were males in the group.

Protocol Analysis

Observational data from both audio and video recordings were analyzed using protocol analysis. The number of utterances were recorded for each group by counting each time a group participant spoke. The only caveat was that each utterance had to have some form of content. Utterances of the type, “hmmm”, or laughter were not recorded. The content of each exchange was also recorded and categorized. Exchanges were considered as a series of utterances where the content or topic remained the same throughout the exchange. For example, an exchange was often found near the beginning of a group session regarding what day of the week the newspaper should be ordered (see Appendix A for details). The exchange could consist of as few as two or three utterances or it could consist of many utterances. A count of utterances were recorded to get an idea of the rates of communication usually found in a task-stage. An analysis of the content of the exchanges was hoped to provide some insight into the types of things usually talked about in each task-stage.

The number of utterances from the audio recording (the FTF condition) were added to the count of utterances from the CMC portion of the FTF condition and analyzed as a whole. The task-stages were then determined by an analysis of utterances and the types of exchanges recorded. The transition from task-stage 1 to task-stage 2, for example, was suggested by a sharp decline in the number of utterances as well as a change in the content of the utterances (see Table 2). Table 16 provides an indication of the number of utterances recorded in each of the experimental conditions.

Table 16. Number of utterances for both CMC and FTF conditions.

Condition	Total Time (minutes)	Total Utterances	Utterances/Minute (Stage 1)	Utterances/Minute (Stage 2-4)
CMC	49.22	388.11	11.53	6.10
FTF	53.25	520.75	14.06	7.62
Mean	**51.2**	**454.43**	**12.80**	**6.86**

The FTF condition generated more utterances and took slightly longer, on average, than the CMC condition. As well the ratio of utterances in task-stage 1 compared to the rest of the task-stages was .43 while the ratio of time spent in task-stage 1 compared to all other stages was about .30. Thus 43% of the total utterances during these group projects were made during the first 30% of the project.

The content of the exchanges were analyzed in conjunction with the frequency of utterances to determine when task-stages changed. A task-stage was considered to change when both the content of the exchanges changed substantively and when the frequency of utterances changed. Figure 8 shows charts of frequencies of utterances for all 18 groups. Notice that if one were to rely solely on the evidence of these charts, it would be difficult to determine when and if task-stages changed. For example, the content of the exchanges in task-stage 1 typically involved what the task was about, who would do what parts of the task, and what counted as data for the task. The content of the exchanges in Task-stage 4 were concerned with completing the project in terms of what was left to include and formatting the final document. When the content of the exchanges changed substantively (e.g., the topic changed from determining the task to creating the newsletter) a task-stage was considered to have ended and another begun. The frequency of utterance data around the same time index was then inspected to determine if any change in frequency was also occurring. This was measured by either noticeable drops or increases in the frequency of utterances.

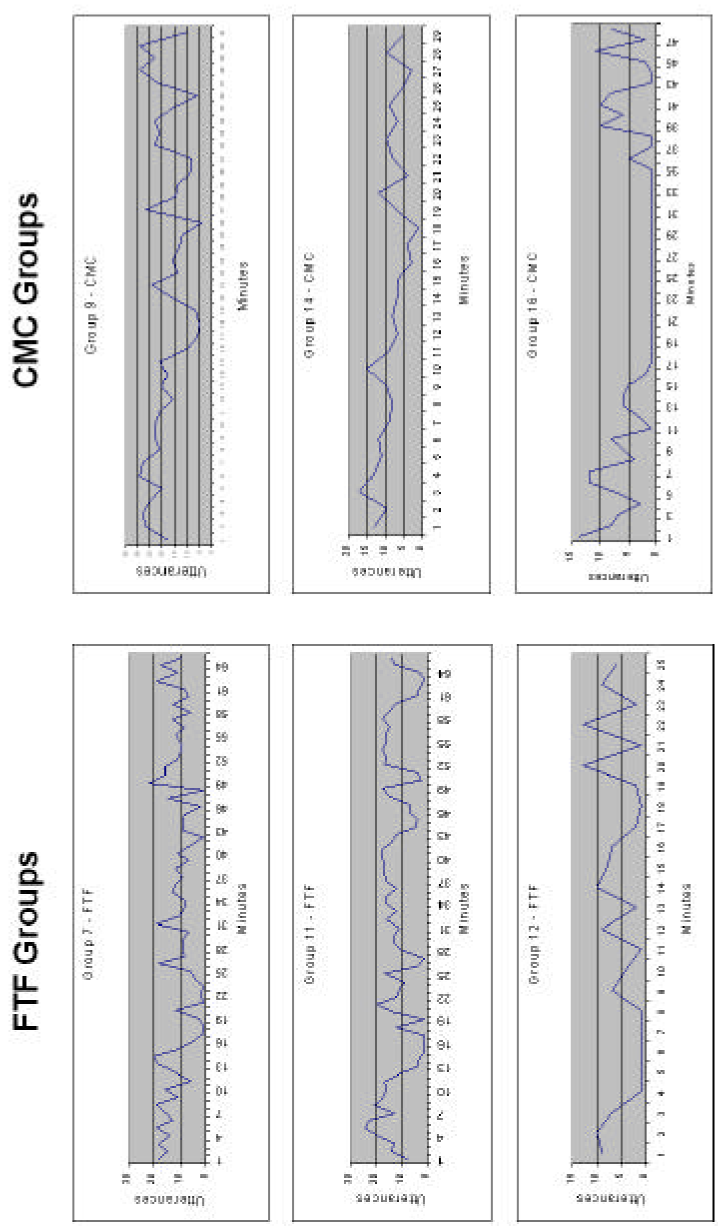

Figure 8: Utterances over time for each of the eighteen groups.

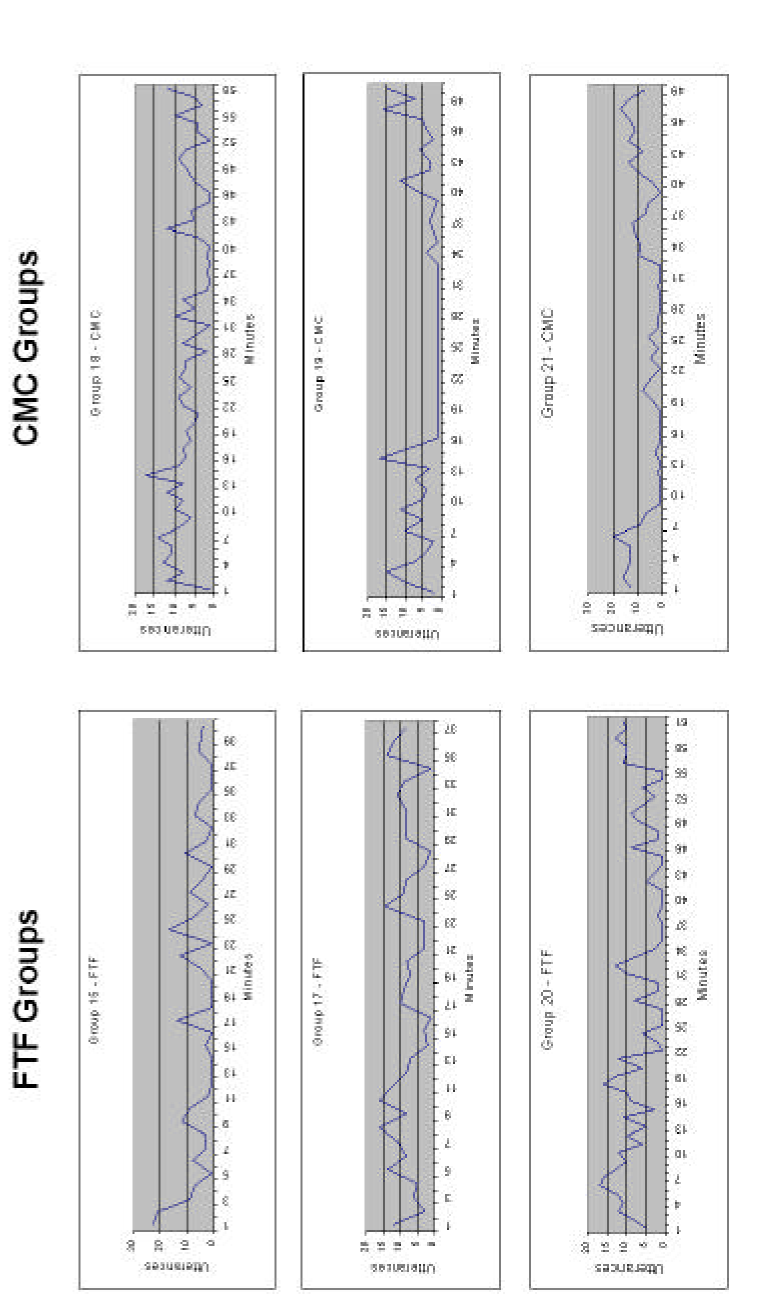

Figure 8: Utterances over time for each of the eighteen groups (continued).

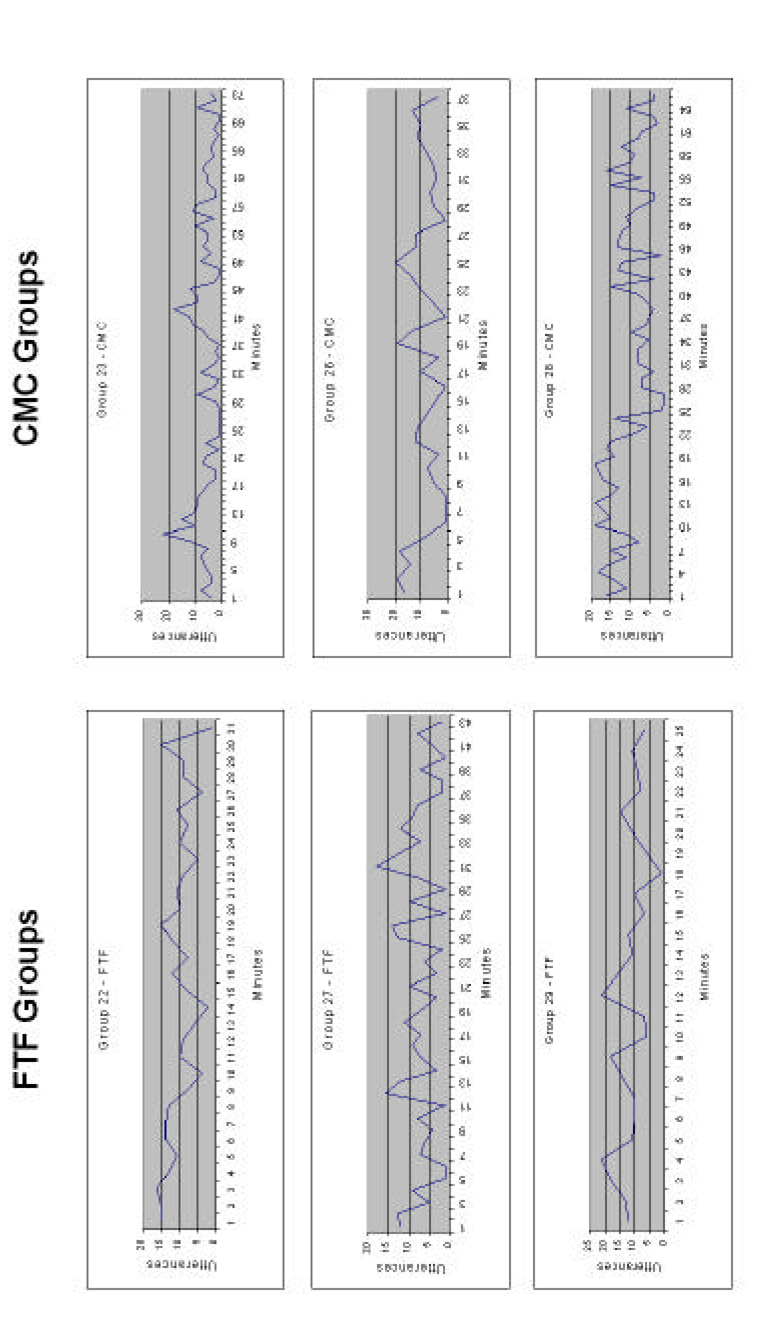

Figure 8: Utterances over time for each of the eighteen groups (continued).

The types of verbalizations found generally followed those suggested by Table 6. Task-stage 1 exchanges, for example, focussed on determining what the project entailed and how to go about completing the project. Task-stage 2 exchanges were typified by few task-related utterances although non-task related utterances were found (e.g., social exchanges). Task-stage 3 exchanges were often requests for updates, verification of a participants understanding of the task, and, in some cases, requests for more work e.g., “I’m done with the sports section, what’s next?” Task-stage 4 most often consisted of exchanges meant to bring the project to a close. In this case that often meant beginning to format the newsletter or editing each others work. Phrases such as “Are we done?” or “I think that’s all we have to do,” were typical of the final few minutes of the fourth task-stage.

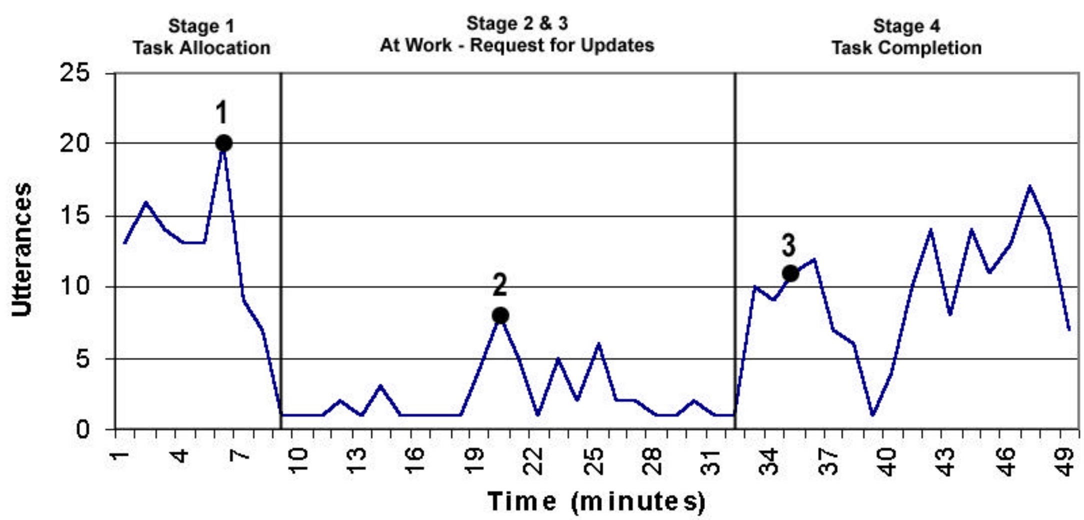

Figure 9: Utterances by Time for a randomly chosen group (CMC in this case). Three typical exchanges are given in Table 17.

Task-stages 2 and 3 are grouped together (see Figure 9). The alternating peaks and valleys within task-stages 2 and 3 indicate a back-and-forth movement between the two stages, from very focused work with few exchanges to bursts of exchanges. The three exchanges indicated in Figure 8 were considered typical of the types of exchanges found in the task-stages they were associated with. Each type of exchange represented similar exchanges in most of the groups. Table 17 provides brief transcriptions of the exchanges indicated in Figure 9.

Table 17: Portions of the three exchanges as indicated in Figure 9.

Exchange #	**Speaker**	**Utterance**
1. Task Allocation	1	So … who wants to do what?
	2	I'll do the "Elkford Senior charged with the death of a Calgary man".
	3	What do you think about that pollution one on the first page? Do you think that one was good?
	1	Yea, that goes with B7.
	1	O.K., I'll do "Catering students get taste of life in the streets".
2. Request for Update		
	1	Which one are you guys doing now?
	2	I was going to do a sports one. Something like …[a justification for doing a particular article ensues]
	1	O.K., what are you doing Speaker 3?
	3	I'm looking for something more national.
	1	O.K.
3. Formatting/ Layout		
	1	How much room do we have?
	2	Should we try to organize what we have?
	1	O.K.

	3	O.K.
	2	O.K., how about one person does … that?
	1	I'll move these [begins to move a postit]
	2	We should maybe do, like, some sort of order to it.
	3	Yea.
	1	Let's put the Calgary stuff at the front.

In each case the content of the exchange suggests the related task-stage. These were used in concert with the count of utterances to help determine where task-stage 1 ended and task-stages 2 and 3 began. Although it may be possible to demarcate task-stages 2 from 3 and 3 from 4, the movement back and forth across stages, particularly stages 2 and 3, made such analysis difficult. While all of the groups exhibited similar patterns of utterances and types of exchanges, some groups were typified by high levels of utterances throughout the task while other groups were typified by low levels of utterances throughout.

Chapter 6: Discussion and Conclusions

A number of interesting things were found in the questionnaire data and from the protocol analysis. Perhaps the most interesting finding was that the idea of task-stages proved out. The protocol analysis clearly identified four stages and showed that the behaviour of stages 2 and 3 cycled back and forth, as suggested by Poole & Holmes (1993). Another interesting finding was that one component, the Anxiety/Prefer FTF component, appeared in all four regression equations. This component was open to two interpretations: (1) it effects were due to a preference for FTF interaction or (2) it was a measure of anxiety.

The findings of this study are discussed in more detail in the following sections. Since the usability and protocol analysis were likely to impact on interpretations of the satisfaction survey results, they are discussed first. Following a discussion of the satisfaction survey results, the implications of this studies findings, for both instructional design and future research are discussed.

Usability Analysis of the Software Interface

In an effort to provide formative feedback to the authors of Teamwave, and to determine where users had difficulty using the software interface, a number of usability issues were considered. User and task observations were conducted by reviewing the video data that was gathered while groups worked on their tasks.

The task was to construct a newsletter for fellow overseas employees. The newsletter was based on a copy of the Calgary Herald. Participants were charged with including 80% Calgary content and 20% national content in an 8 inch by 8 inch, single page newsletter. Group members were separated and had only the software and audio with which to create, edit, and format the newsletter.

Prior to beginning the CMC component of the group projects, each group of participants was given a brief demonstration of the tools they would be using. This included how to use the microphones and headphones and how to use the features of the software that were pertinent to completing the project. This involved a 5 minute demonstration of how to create, use, and delete postits. The software was presented to the participants already running. The details of starting up the program, logging in, and ensuring everyone was in the same place were handled by the experimenter. A sample of the startup screen is shown in Figure 6. No instruction was provided regarding how to use any of the drawing tools or any other tools. Participants were instructed to leave the program running when they were finished.

The primary usability issue considered was whether participants could use the postit tool given the limited instruction provided. The answer was overwhelmingly affirmative. In several cases one or two participants made comments such as “How do I move these things around?” or “How do we resize them?” and “How do I get another postit?”. In every case one of the other group members was able to provide the answer. In several cases one participant took charge of creating new postits for the other members. Similarly, when creating the final layout, one member was often designated, or took it upon themselves, to move the postits around while the other members provided verbal feedback. For example, in one segment a group member charged with moving and resizing the postits was guided by comments such as, “No, more to the left” or “Yes, that’s where it should go.”

An issue of interest was, how would participants use the postits? Although it was possible for more than one person to use a postit, after attempts by several groups to simultaneously edit a postit, these attempts were abandoned and each group member used their own postit. In one case participants used three postits, one for each member, for the entire newsletter. In others many postits were used, one for each article (see Appendix E for two examples). This appeared to be the predominant choice with 17 of the 18 groups using more than three postits.

The conclusion was that the postits were both easy to use and were appropriate for the task. Participants spontaneously used postits for articles suggesting a good fit with task requirements. Also, the training proved adequate as no groups had difficulty using the postits.

In several cases participants appeared to have expectations about the presence of particular features. Several groups felt that formatting the newsletter included font manipulation. These groups felt that titles, for example, should have larger, bolded fonts, and regular text should be smaller with styles applied. Unfortunately Teamwave did not support font manipulations of any type. Participants spent anywhere from 1 minute to nearly 5 minutes searching Teamwave for a way to change the fonts. From the dialogue that ensued it was clear that there was an expectation that these features would be available. For example, in one exchange a participant was adamant that a tool for changing fonts had to be there, “There’s got to be way to change the text!” In a few cases participants used the drawing tools to fashion their own newsletter titles. Although the lack of font manipulation features did not hinder creation of the newsletter, it undoubtedly had an impact on participant’s perception of the software. Perhaps the general feeling of participants who found the lack of this feature inadequate, was summed up by one participant who called the software “pretty primitive.”

The initial training did not involve the drawing tools. However, a number of groups did use the drawing tools to do things like create a title for the newsletter or draw pictures or cartoons on the whiteboard as an adjunct to the newsletter (see Appendix E). The drawing tool that was used the most was the free-hand drawing tool. Despite the fact that the icon for this tool was far from obvious (see Figure 10), participants were able to find and use the tool with little difficulty.

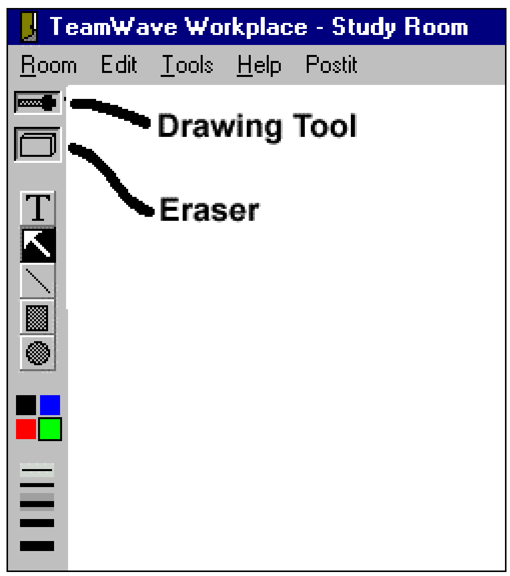

Figure 10: The toolbar on the left of the figure was used to select the Drawing Tool and the Eraser Tool.

A larger usability problem arose when participants attempted to erase parts of a picture. The eraser did not appear to erase completely nor would the eraser work on objects. For example, one group attempted to draw five circles corresponding to an article on the olympic games. The circles were objects. The eraser would not remove the circles because they were objects. In one case a participant discovered the “clear whiteboard” feature and, perhaps due to a lack of a warning, deleted approximately 10 minutes of work from the whiteboard. However, as can be seen in Appendix E, groups persevered and were able to add graphical elements to their newsletter. These difficulties, particularly with font manipulation and difficulty of clearing parts of the whiteboard, surely contributed to their satisfaction with the software, and probably with the project.

In a different, but related usability issue, efforts were made to ensure the software was stable and easy to use. To reduce the potential difficulties encountered by participants the software was presented to the groups already started. As a way of easing the burden on the experimenter, icons were placed on the software desktop and set up so that double-clicking the icons would automatically start the software and begin the login process with the Teamwave server. As well, guest accounts had been created on the server such that no passwords were required to log on. The user simply had to hit the enter key to complete the login process.

Two groups had the software crash on them. All three participant machines crashed within a space of 5 minutes. By virtue of the icons and guest accounts, at least one user was able to re-start TeamWave and to log on. This participant, using the intact audio channel (audio was provided by separate hardware), was then able to guide the other participants through the restart process and the groups were able to continue on. Due to the persistent nature of TeamWave, none of the work was lost. It should be noted that these groups were quite proud of themselves and suggested that the software crash was, perhaps, part of the experiment.

The postit tools did not appear to present any usability concerns. However, for roughly half the groups that attempted to manipulate the fonts, or use the eraser, difficulties were encountered. These undoubtedly affected participants reactions to the software, although probably not enough to affect the users satisfaction with the software to any large degree.

Protocol Analysis

In order to confirm that the group task used in this study was composed of stages, and that each stage had its own characteristics, a protocol analysis of the video data was performed. Three task-stages were initially identified. As was shown in Table 17 and Figure 8, task-stage 1 was clearly identified. The number and ratio of utterances in this stage, was high compared to any other stage. The content of the exchanges were also unique, concerned mainly with defining the task and determining task allocation. There was little in the way of political negotiation (competing interpretations of how the task should be approached) however group leaders tended to emerge, when at all, during this task-stage. Task-stage 2 appeared to be made up of alternating states. The spikes or increases in utterances during task-stage 2 were generally requests for clarification. In the hypothesized task-stage model (see Table 2), four stages were proposed. However, the proposed model contained two intermediate stages while only one was found here. A closer inspection showed that the two middle stages correspond to the alternating peaks and valleys found in the middle stage here. That is, in the proposed model, task-stage 2 consisted of non-task related interaction, or very low levels of interaction. Task-stage 3 consisted of, for example, requests for confirmation. Poole and Holmes (1993) suggested this may be the case as participants go back and forth between the stages. The peaks found here correspond to task-stage 3 and the valleys correspond to task-stage 2. Thus the findings of this study confirmed four task-stages and demonstrate a period of oscillation between stages 2 and 3.

Satisfaction Survey

The satisfaction survey was constructed to measure a number of personal variables and their influence on satisfaction. Attitudes towards computers, for example, was expected to influence satisfaction with computers. Similarly, experience with groups was expected to influence satisfaction with group projects. The statistical methodology used (regression analysis) can help to determine how much of a contribution attitude made towards satisfaction, how much experience made towards satisfaction, and how much the experimental manipulation contributed to satisfaction. In this way it was possible to determine where optimizations in instructional design would be most beneficial. If it were found that greater experience with computers resulted in higher levels of satisfaction with computers, then it would make sense to design an instructional sequence with an emphasis on more computer experience.

Regression analysis can also provide measures of relatedness between the predictor variables. When correlations between predictor variables are low, the variables contribute to the each others variance very little. When correlations are high, the contribution may be higher. In the latter case, it may become necessary to explain the variables, not only as they contribute towards a criterion or criterion variable, but also how they relate to each other. In analytic terms, if the predictor variables are not related to each other, they can be discussed separately. In turn this allows the discussion to focus on the effects of one variable with more confidence that a rule of *cateris parebis* (everything being equal) is likely to hold true (Neter, Wasserman, Kutner, 1985).

In this study the correlations between the coefficients of the predictor variables in each of the four significant equations, was below 0.30. In all but one case, the correlation was below 0.13. Such low correlations mean that each of the predictor variables can be discussed separately from one another. The strategy in this section will be to discuss each predictor variable with its associated satisfaction component. Thus the regression equations will be discussed as univariate (one variable on each side of the equation).

i. Experience with Chat Groups → Perceived interaction

A direct interpretation of the relationship between the two components given in the equation would be that as a person's experience with chat groups increases the likelihood of being satisfied with the interaction between themselves and other group members also increases. There are a number of possible reasons for this relationship. For example, the amount of experience people have had with chat groups may help mitigate any negative reactions to the groupware used in this study. A second explanation, and one that is perhaps more in line with personal observations, was that experience with chat groups provided a different perspective of the groupware used in this study as compared to those who had little or no experience with chat groups. It may be that people who have participated in chat groups understand the limitations of technology. For them, the audio component of the groupware provided in this study represented an improvement over text-based chat. The people who do not participate in chat groups were more likely to see the groupware as inadequate compared to what they normally expect e.g., telephone or FTF interaction. Thus the people who participated in chat groups were more likely to be satisfied with the interaction than were those who did not participate in chat groups.

Anecdotal evidence from the following example suggests the second explanation may be the case. In the earlier days of computing it was common to see small groups of people extolling the virtues of advances in computer technology. At the time, video clips could barely be played on people's home computers. While these small groups of enthusiasts were talking about the advances in technology, the larger population tended to see these small, jerky video clips as very poor imitations of television and video. For the former group, they represented advance. For the latter group, they represented steps backward. It is suggested that similar population differences hold true in this study. People who are likely to participate in chat groups, particularly given the text-based nature of current chat implementations, are more likely to appreciate incremental improvements in technology. The segment of the population that did not use chat groups are not likely to appreciate anything less that what is currently available from other communication mediums. An attempt was made to determine if the data supported a bi-modal distribution as was suggested. Of the three items comprising the component “Chat Groups,” two showed a strong negative skew suggesting most people had rarely used chat or newsgroups. The third item, however, asked if chat was a unique way to communicate. In this case a bi-model distribution was discovered, suggesting a sub-population who thought chat was unique and a sub-population who did not think it unique.

While it is generally accepted that any given construct should be measured by at least 3 items (Kline, 1986), the “Perceived interaction” construct was measured by only two items. However, Kim and Mueller (1978) suggest that if the items confirm results from prior reliable studies, then two items may be sufficient. Both of the items were, in fact, drawn from Fulford & Zhang’s study (1993) and confirmed their findings i.e. that satisfaction with overall interaction was generally higher but that both items contributed to perceptions of interaction using computer-based communication methods.

A consequence of the above interpretations, as far as instructional design is concerned, is that designers should be aware of the differences that may exist between student populations. However, it should be noted that only about 8.5%

of the variance in “Perceived interaction” was accounted for by the “Chat Group” component. Thus, the impact of spending any amount of time designing instruction to increase experience with chat groups may, at most, result in an 8.5% increase in “Perceived interaction.” Consequently it is suggested that instructional designers be aware of the possibility that their student population may vary in terms of experience and attitude, and that this may affect their perceptions of interaction among group members. However, any “tweaking” of the instructional design in this area may produce only minimal results.

ii. Regular Computer Experience → Satisfaction with Group and Task

“Regular Computer Experience” was measured by asking participants to estimate the number of hours per week that they spent using a computer. This equation suggests that the more time they spent on the computer, the more likely it was that they would be satisfied with the group task and with the other group members. In this particular equation, the correlation between “Anxiety” and “Regular Computer Experience” was highest, at .27. The correlation, although noted, was not considered strong enough to warrant joining the two variables for discussion purposes.

The median number of hours per week spent on computers was 5.5 hours and ranged from 0 to 42 hours. The mean factor score for “Satisfaction with Group and Task” was 4.97 out of 7. This indicated that many participants were only marginally satisfied. It should also be noted that the variable “Regular Computer Experience” accounted for only 5.9% of the variance in the satisfaction variable.

Given that people are already using computers on a regular basis, and that experience only accounted for 5.9% of the variance in “Satisfaction with Group and Task”, it is difficult to see that any efforts to increase daily experience would be met with large gains in satisfaction. That is, if people are already using computers about an hour a day, a point of diminishing returns may have already been reached. Increases in daily use may need to be fairly large before any increase in satisfaction may be seen.

iii. Attitude/Experience with Groups - Range of Experience → Impression of Personal Connection and Affiliation

Rather than spend much time discussing the predictor variables in this equation separately, particularly given the low reliability of the satisfaction variable, they are discussed together.

An interpretation of this equation was that a more positive attitude towards, and experience with, groups and a narrower range of computer experience will result in an increased likelihood that people feel that they made personal connections with other group members. It is likely, for example, that a person who has had a number of positive group experiences will develop a more positive attitude towards group projects. In turn, this person will be more likely to perceive a personal connection in proportion to the amount of positive group experience.

In similar fashion, the narrower the range of computer experience, as expressed by the number of productivity types of software people use, the more likely it was that people would feel they had made a connection with another group member. For example, a number of group members began their groupware interaction by apologizing for their lack of experience with computers. In fact, the mean factor score for this component was 2.51 out of 7. This indicated that most people had very little experience with, for example, database, spreadsheet and on-line group tasks. This may have created an atmosphere of shared adversity. The greater the adversity, measured in terms of the range of software used, the more likely that people would feel they shared something with other group members resulting in a perception of connectedness.

Observations made during the study suggested that a post-hoc analysis of the group composition by gender was warranted. The results suggested that there was indeed a significant relationship between the ration of male to female group members and perceptions of personal connectedness with other group members. Specifically, a ratio of 2 female to 1 male appeared to produce the highest ratings of personal connection. The lowest ratings were generated by a ratio of 2 male to 1 female (see Table 6). A subsequent literature search failed to provide evidence in support of these findings. However, neither did they provide contradictory evidence. Rather, the search was characterized by little data. Without further inquiry it is difficult to attribute any explanation to these findings.

It should be noted that the “Impression of Personal Connection and Affiliation” component was composed of only two items. Also this component lacks reliability as determined by an alpha coefficient of only .38 (.70 or above, is generally accepted as reliable). This suggests that the component “Impression of Personal Connection and Affiliation” would likely change or change in relationship to the predictor variables should more participants be included or the study repeated.

As the equation was found to be weak, and no explanation was offered for the group composition findings, no recommendations are offered for Instructional Designers.

iv. Experimental Variable (CMC v.s. FTF) → Satisfaction with the Software

The experimental variable was coded so that CMC was 1 and FTF was 0. Thus the CMC condition resulted in greater satisfaction with the software than the FTF condition. The implications of this finding are discussed below.

Upon returning from the CMC portion of the study, several groups volunteered that they had found the use of audio, along with the shared tools, to be much more productive and easier to use than their experience with FTF group work. Their claim was that the groupware, especially the audio, allowed them to focus on the product while interacting with other group members. When doing similar activities, they had found that it was more difficult to work when working FTF with group members. The primary reason offered was that the FTF condition required them to look at group members, which in turn required them to change focus from the product. This suggested that the mix of groupware and task, in the CMC condition, was entirely appropriate. A post-hoc question was asked of groups returning from the experimental session, "If you had to use the software to perform another group task from start to finish, would you?" The overwhelming response was "Yes" from the people in the CMC condition and "Maybe" in the FTF condition. It may that the mix of groupware, FTF, and task was not appropriate, that the FTF condition may have detracted from a satisfaction with the software because it was more difficult to focus on the task.

These findings suggest that people are more likely to be satisfied with the software if the groupware and task are well matched. Certainly this is Gutek's claim (1990). She makes the argument that software should match the work to which it is being put. Inappropriate matching of software and task will result in frustration. The explanation suggested above falls in line with this reasoning.

Despite the fact that the contribution of the experimental variable was small, it was still significant. If satisfaction with the software is an issue in an instructional sequence, then more attention should be paid towards matching software with task.

v. *Anxiety/Prefer FTF → Perceived interaction*
Anxiety/Prefer FTF → Satisfaction with Group and Task
Anxiety/Prefer FTF → Impression of Personal Connection and Affiliation
Anxiety/Prefer FTF → Satisfaction with the Software

The component "Anxiety/Prefer FTF" contributed to all four satisfaction components. With the exception of "*Impression of Personal Connection and Affiliation*," an increase in anxiety resulted in an increase in satisfaction. In the latter case, a decrease in anxiety resulted in an increase in "*Impression of Personal Connection and Affiliation.*" As there are two possible explanations for this component, as suggested by its label, each will be discussed in turn.

The two items that made up the "Anxiety/Prefer FTF" component were, "I would rather communicate with someone FTF than by telephone" and "I would rather communicate with someone FTF than by computer."

The most straightforward explanation, based on the content of these items, is that people simply prefer FTF when given a choice between telephone or computer. Certainly these were the findings of Galegher & Kraut (1992) and D'Ambra, Rice, & O'Connor (1998). In both of these studies participants were found to prefer FTF interaction even when less rich, but more appropriate, media were available. However, this explanation suggests that for the first 3 equations, the stronger the preference for FTF, the greater the likelihood that they will be satisfied. For the last equation, the less they prefer FTF the greater the likelihood of a perception of connectedness. But these interpretations seem counter-intuitive. If participants prefer FTF over telephone or computer communication they should be less satisfied in the CMC condition, not more satisfied. An alternate explanation is offered whereby a preference for FTF is a measure of anxiety.

As with several other components, anxiety/prefer FTF was measured by only two items. However, both of these items confirm the findings for similar items used by King, Henderson, & Putt (1996). In their study, they were interested in how anxiety affected students use of the WWW and email. Items similar to the items in this study asked, for example, if students preferred using web-based lectures to FTF mass lectures. Items loading in the other direction included, “If I could avoid using the web I would.” These items were part of a set of 29 items that were found to be highly correlated and reliable. King, Henderson, & Putt concluded that their items did measure anxiety towards CMC. If the items in the anxiety/prefer FTF component do measure anxiety, then an alternate explanation (to prefer FTF) for the relationship between this component and the satisfaction component, can be made.

Keeler & Anson (1995) found that college students with high anxiety towards computers exhibited large reductions in anxiety as a function of computer use. Furthermore, performance and learning retention were higher in cooperative learning groups particularly amongst high anxiety students as compared to high anxiety students in individual learning sections. They drew the following conclusions: (1) reductions in anxiety from the beginning of the study as compared to anxiety levels at the end of the study were most dramatic when the initial anxiety was high whereas low anxiety students showed little anxiety change and (2) that students performed significantly better in the cooperative learning groups than in the individual learning groups. In their study measures of anxiety were obtained at the beginning of the study, in the middle, and at the end. Unfortunately such was not the case in the current study. However, it is suggested that had the measures been taken, similar results would have been obtained.

Thus it is suggested that the anxiety levels at the end of the study were low while at the beginning of the study they were generally high. One way to think about how dramatic the decreases in anxiety were is by illustration (see Figure 11). The idea is that people operate within a normal range of anxiety. Below the operating range will result in boredom. Above the normal operating range will result in poor judgement.

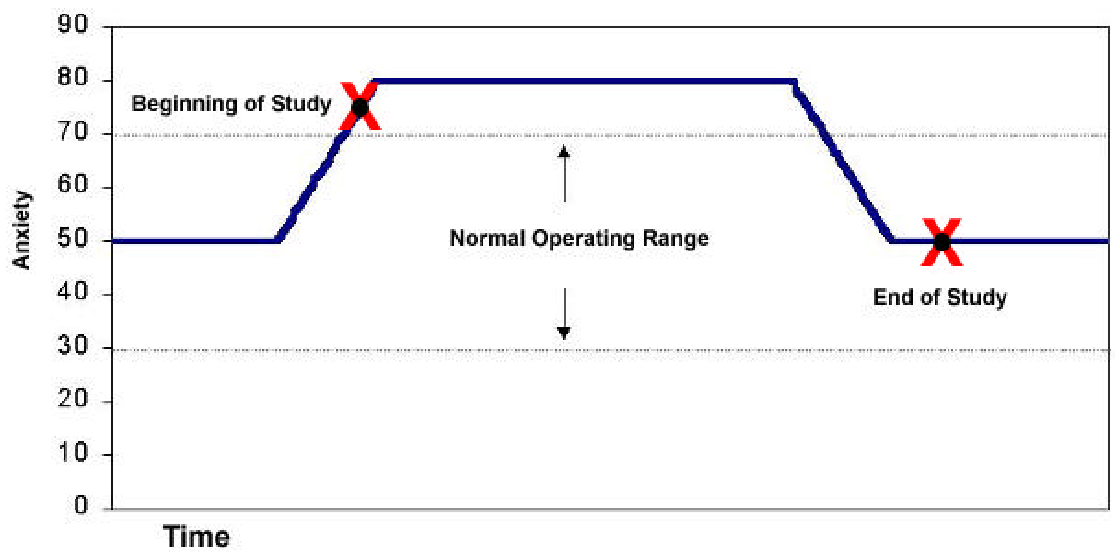

Figure 11: The Anxiety curve exhibited by many participants in this study.

A number of participants, upon discovering the extent of computer use during the study, said that they were concerned their lack of computer and/or typing skills made them inappropriate participants for the study. Several participants made the following comment (paraphrased), “I’m not very good with computers. I hope that won’t screw up your study. Do you want to get someone else?”. Together with the generally high anxiety levels (the mean factor score was 5.60 out of 7), these anecdotal data suggest that many participants entered the study with anxiety levels near or above the normal range of anxiety.

When participants returned from the CMC part of the study, the change in demeanor was notable. Whereas many groups had entered the CMC part of the study with anticipation and were generally quiet and tentative, almost all groups returned laughing and talking amongst themselves. Based on this anecdotal evidence, it is suggested that participants were far less anxious at the end of the study compared to the beginning of the study.

It should be noted in Figure 11 that participants ended the study in proximity to higher levels of anxiety. That is, the length of time between the beginning of the study, and the high initial anxiety, and the end of the study was short, lasting about an hour. It may be that proximity to recent high anxiety resulted in greater levels of satisfaction, or perhaps relief, which may translate into the same thing. That is, the recent large anxiety drop was still fresh in the participant’s minds. Their sense of satisfaction may have stemmed more from relief than from true satisfaction. However, if the study were longer, it may be that initial high anxiety would constitute a smaller portion of recent experience. That is, the length of time spent in the normal anxiety range would be long enough to “forget” the initial high anxiety. Thus measures of satisfaction would indicate generally lower, but more stable, levels of satisfaction in a longer study as compared with a shorter one.

As for the fourth equation, lower anxiety levels may have made it easier to feel that a participant made a connection with other group members. That is, higher anxiety levels may have interfered with the ability to “connect” with others. Of course, it may be that the group composition mitigated effects here. An optimal group composition may have promoted “made a connection” more than anxiety. In fact, anxiety only accounted for 7% of the variance in “made a connection”!

Essentially, the argument put forward was that (1) the reduction in anxiety was greatest for those with higher initial anxiety and that (2) a study of longer duration may ameliorate inflated satisfaction levels. In terms of instructional design, this means that exposure to new groupware may result in initially high anxiety levels but that these levels will likely drop. It also means that initial reports of satisfaction may drop in the longer term. Practical application of these findings suggest that when introducing new software, or a new way of using it, a practice session may be of benefit. A practice or tutorial session may bring students past initial high anxiety levels, thus ending the session when students have returned to normal anxiety levels. The length of time necessary for such to occur may vary. The groups in this study worked with the groupware for about 50 minutes. This was long enough to get past initially high anxiety levels, but not long enough to reduce inflated satisfaction levels. Of course, this may be leveraged so that students end their first session with optimal satisfaction levels, a “high” as it were, thus motivating student to return to subsequent sessions.

Satisfaction Survey Limitations

There were a number of problems with the satisfaction survey related both to the number of items per component and to the size of the sample population.

As was shown in earlier sections, three components, both predictor and criterion, were composed of as few as two items (Anxiety, Satisfaction with the Interaction, and Made a Connection). Although two of the components relied on prior studies for their strength, the third did not. Even though prior evidence supported the use of only two items, many researchers would not be satisfied unless three or more items comprised a component (Kline, 1986). The idea is that more items will more fully describe a component. Few items may result in an incomplete description of the component. Thus the descriptions ascribed to components, and their explanatory power, should be viewed cautiously for these three components, and especially for the third.

Perhaps the primary limitation of the satisfaction survey data was related to the low number of participants per survey item. A generally accepted “rule of thumb” is that 10 participants are required per survey item to provide for a reliable factor analysis (Kline, 1986). That meant a minimum of 260 participants was required for the predictor variable factor analysis (26 items * 10 participants) while a minimum of 180 participants was required for the criterion variable factor analysis. The argument generally offered for higher numbers of participants per item is related to error; the more participants, the smaller the measurement error. That is, the larger the sample population, the more likely the results will reflect the general population. Thus any results based on populations of less than 10 participants per item should be considered suspect and generalizations made cautiously.

Kline (1986) discusses evidence from prior work that suggests a population of 2 participants per item will generate results very much like that of populations of 10 participants per item. That is, the power gained by additional participants per item, over and above 2 participants, is small. Thus survey data that was generated from populations of 2 or more should be considered adequate for hypothesis testing. However, he does suggest that a minimum population size be more than 100, in total, regardless of the number of items.

The number of participants in this study was 64 for the predictor variable analysis and 54 for the criterion variable analysis. In the former case that meant a population of 2.4 participants per item and 3 participants per item in the latter case. While the per item population was well within the guidelines discussed by Kline (1986) the total populations were each below 100. While it may have been possible to continue until 100 people had participated, logistically this was not considered worth the extra time, particularly as the number of participants per item was within acceptable limits. In addition, although the participant turnout was quite high initially, it became much more difficult to recruit participants particularly after the end of February (a little past mid-point in the semester). For example, in the final two weeks of the study some 12 groups of 3 people each were scheduled to participate. Due to cancellations or no-shows, only 4 of the 12 groups actually completed the study.

Given the foregoing discussion, the findings and interpretations from the satisfaction survey data should be viewed as exploratory but with a stronger likelihood of being correct than some theorists would suggest (e.g., Kline, 1986).

Implications for Instructional Design

There were two findings that have implications for instructional design: (1) the confirmation of group task stages and (2) the finding that CMC provided the best “fit” for the task used in this study.

Task-Stage Confirmation

The confirmation of group task stages provides instructional designers with a model for making more precise instructional interventions. Rather than construction of a generalized instructional design for a group project, individual stages may be targeted. As the first and last stages appear to have higher interaction requirements, greater support needs to be provided for these stages as compared to stages 2 and 3. In fact, some universities have structured mandatory attendance at quarterly (every three months) weekend sessions for their distance-based courses (Collings & Walker, 1995). These sessions often signal the beginning of a new project or the completion of an old one. In either case, the attendance requirement allows students to either begin or wrap up group projects FTF, thus providing the richest medium possible only when necessary.

The Concept of "fit"

The experimental intervention used in this study involved manipulating the communications media during task-stage 1 of a cooperative learning project. The choice of media was driven by a desire to test or "fine-tune" our understanding of Daft & Lengel's communications model. It was suggested that the communications media that provided the best "fit" with the task requirements would result in the highest levels of satisfaction. The findings suggest that Daft & Lengel's conception of interaction requirements are most appropriately used for determining the best "fit" between software and task. That is, the experimental condition produced significant effects only in the area of satisfaction with software. Thus the application of the model only makes sense in determining the most appropriate task-software "fit". And, as Gutek has suggested (1990), the best "fit" is more a function of appropriateness than of interactive capacity (the richness of the media).

Instructional designers should make use of Daft & Lengel's model to determine the most appropriate software support for a cooperative learning task or task-stage. If a description of the types of activities that one expects to be found in a task-stage can be determined, perhaps by task analysis, it is possible to predict the most appropriate software for the task-stage. A good "fit" between software and task will result in more satisfied students. And, more satisfied students should be more motivated to continue using the software.

Directions for Future Research

A number of “threads” of research are suggested by this study. In particular these include continued work on a satisfaction survey, continued refinement in the use of Daft & Lengel’s model, and further research into the influence of anxiety on computer supported cooperative learning.

Satisfaction Survey

The satisfaction survey had the potential to help determine the components that make up satisfaction. A better understanding of how attitudes towards CMC contribute towards perceptions of interaction, for example, could provide insight into the importance of these variables. However, a small population and, in some cases, limited items per component, made interpretation of the findings of this study difficult. It is suggested that further research be conducted into the use of a satisfaction survey. In the process, larger populations should be used whenever possible. And, the survey should be refined so that the number of items per component is at least 3, and more if possible.

Interaction Model

Daft & Lengel’s model proved to be useful in determining the best “fit” between software and task. However only one software tool and one task have been tested in this study. The results from this study, however, suggest that further research into the use of this model should be fruitful. In particular, different software and task configurations will help to “fine tune” the application of the model. Furthermore, the confirmation of task-stages suggest that further refinement is possible in per stage as well. Therefore it is suggested that researchers continue to test and fine tune the application of Daft & Lengel's model using a variety of software and task or task-stage configurations.

Anxiety/Prefer FTF

The interpretation of the anxiety/prefer FTF component was made difficult by the low number of items (2) that made up the component and by the low number of participants. However the implications of an anxiety interpretation could be far reaching. That is, if anxiety truly exists, then instructional designers may need to take it into account in their designs. Thus it is suggested that research into the existence of an anxiety construct should continue. Of immediate importance is the construction of an anxiety measurement tool that is more readily interpreted. More items and more participants should help provide this. As well, anxiety change over time should be measured. This would help to determine whether or not anxiety is an issue that need be addressed. It may be, for example that anxiety change is slight and not worth the effort of addressing. On the other hand, it may be that anxiety change is great but that it's time course is very short. In this case, an introductory session with the software may produce the desired anxiety drop.

In each of these cases further research should help to confirm or reject the findings of this study. Regardless, these appear to be worthwhile areas of study.

Conclusion

This study examined the integration of distance and cooperative learning with the support of communications software (groupware). It was the contention of this study that an understanding of the types of interaction that occurred between group members during a distance-based cooperative learning project would help to determine the best “fit” between task and software support. As a means of sifting out the experimental treatment from external factors, such as attitude and experience, a survey was used to gather data and a regression methodology was used to interpret the data. It was also the contention of this study that tasks were composed of stages and that these stages could be described. Based on prior work and an analysis of the task used in this study, task descriptions were determined. An experimental design was constructed using Daft & Lengel’s interaction model as a tool to help determine interaction levels given a description of the kinds of interaction found in task-stage 1.

Two research questions were proposed for study. The first question was,

> “*Will varying communication modes between audio and FTF during the first phase of a cooperative learning task, while maintaining audio/graphic only modes for the rest of the task, produce measurable differences in participant satisfaction?*”

Although results have been presented regarding differences in participant satisfaction it is unclear if the differences are large enough to warrant consideration. The ANOVA analysis, for example, did not indicate any statistical difference between the two communication modes while the regression analysis did. This in itself suggests the differences were small, detectable by one analytic technique but not another. It must be remembered, however, that a different task may have produced different results. That is, a task that produces more of the types of interaction suggested by McGrath (1. the initial task determination, task allocation, and political interaction, 2. on tasks, 3. group processing, 4. construction of deliverable) may be more likely to produce differences between communications modes. However, for the task used in this study, the differences were small.

The second research question was,

> *"Will participants interact in patterns similar to those suggested by the task-stages described by a Jigsaw I cooperative task?"*

A Jigsaw I task is a technique that breaks tasks into pieces. The general structure of a Jigsaw task involves either students or instructor dividing the task into pieces and distributing the work amongst group members. The group returns with their pieces ready for assembly into a final product. It was suggested by this study that a Jigsaw I task most closely approximated the general structure of group projects found in post-secondary courses. It was also suggested that group projects were typically composed of stages although it was entirely likely that groups would move back and forth between stages. The power of such an observation was that it becomes possible to look at task–stages rather than entire tasks when attempting to determine the types of media support necessary. Media could be tailored to each stage thus making better use of resources.

The protocol analysis showed that task stages were evident and that each stage was characterized by types and levels of interaction. Task-stage 1, for example, was characterized by discussion of the task, task-allocation, and determining what counts as data (e.g., the articles to use). In Daft & Lengel's terms, the first task-stage sought to reduce uncertainty (determine what counted as data) and to reduce equivocality (determine what the task was all about). The higher levels of interaction were consistent with predictions made by their model. Similarly, task-stage 4 was characterized by discussion of what remained to complete the task and how to format the newsletter. In this instance uncertainty was only moderate as much of the task had already been completed. The group had already decided most of what would count as articles (data). However, equivocality was somewhat higher as groups sought to determine what counted as a finished product. Generally, equivocality was the highest at the beginning of the task, lowest in the middle, with a rise near the end of the task. Uncertainty followed similar patterns.

Although the choice of task type (Jigsaw I) dictated task-stages, by constraining the study in this way it was possible to look more closely at what went on during task-stages. By translating the findings into Daft & Lengel's language of uncertainty and equivocality, confirmation of their model was provided. That is, higher levels of uncertainty and/or equivocality, as indicated by the content of exchanges during a task-stage and the frequency of utterances, did result in higher levels of interaction.

Thus while task stages as described by Jigsaw I tasks were evident, and tended to provide support for Daft & Lengel's model, the results of this study did not provide unequivocal evidence in favour of either audio or face-to-face communications modes for tasks such as the one used.

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Appendix A: Task Descriptions

Task Description - CMC

The Context

You work overseas for a large Canadian company. The company headquarters is composed of a number of office and research buildings. Unfortunately not much planning went into this complex. The buildings are widely spaced often requiring some form of transportation between buildings (a car). This means each building has its own cafeteria and lounge area.

You quickly discovered that not only are most of your co-workers are from Canada, almost 80% are from Calgary, where the head office is. Many of you have been overseas for more than 6 months and welcome any news from home. Unfortunately access to outside news sources, other than personal mail, is curtailed by poor roads and telecommunications in the area. More reliable transportation routes, such as by airplane, are expensive. Most of the people working here can not afford such things as regular newspapers. Similarly local radio and television programming tend to exclude most of the news of the outside world. Satellite access is available but is also expensive. The result is that few people know what is going on either in the world or in the Calgary area (where you're from).

Three of you decide to approach the company boss and see if the company will pay for the regular delivery of a newspaper. You place the request with your boss.

> *In exchange for the regular delivery of a newspaper, you will provide a weekly newsletter summarizing items from the newspaper that you feel most of your co-workers would want to see. The newsletter would then be distributed to all your Canadian co-workers using the company internal mail system.*

The company agrees providing the following conditions are met:

1. *The newsletter must provide for all the Canadians working at your location in roughly equal percentages (at least 80% Calgary content, 20% National content).*
2. *You may use company equipment to assemble and distribute the newsletter.*
3. *You* **may not** *use company time to assemble the newsletter.*

4. *Only one newspaper per week will be flown in (the Calgary Herald). You must decide which day would likely contain the most relevant news items and sections.*
5. *The newsletter must be no more than one page in length.*
6. *A sample newsletter must be submitted for approval before proceeding. The sample newsletter should give your boss an idea of what to expect in the real newsletters.*

You agree.

Using a combination of telephone and email you arrange a preliminary meeting between the three of you. As a group you decide that you need to do some planning. An agenda is agreed upon with the following items: (1) you need to come to an agreement about which day's newspaper to have flown in, (2) what sorts of items to summarize for the newsletter bearing in mind the constraints the company imposed, and (3) to produce a sample newsletter from an old Calgary Herald (in fact you were able to find three copies). Since this is on your own time, you all agree that you should spend no more than about 20 minutes on the first two items and 30 minutes on the third.

Unfortunately no two of you work in the same building. This means that a lunch hour meeting is out of the question. By the time some of you arrived at the same cafeteria, you would have to leave again.

You agree to meet electronically at lunch time. The company provides adequate groupware (software for communicating with each other) so that you can address all the agenda items: (1) what day to get the paper, (2) what sorts of items to include, and (3) assemble the sample newsletter on-line. You agree, however, to spend no more than the agreed upon time (20 minutes on the first 2 items, and 30 minutes on the last item). Each of you will then be able to print a copy of the sample newsletter for yourselves. One of you will submit the sample to your boss for approval.

* Note: Please indicate in the top left corner of the sample newsletter which day of the week the newspaper will be flown in.

Task Description - FTF

The Context

You work overseas for a large Canadian company. The company headquarters is composed of a number of office and research buildings. Unfortunately not much planning went into this complex. The buildings are widely spaced often requiring some form of transportation between buildings (a car). This means each building has its own cafeteria and lounge area.

You quickly discovered that not only are most of your co-workers are from Canada, almost 80% are from Calgary, where the head office is. Many of you have been overseas for more than 6 months and welcome any news from home. Unfortunately access to outside news sources, other than personal mail, is curtailed by poor roads and telecommunications in the area. More reliable transportation routes, such as by airplane, are expensive. Most of the people working here can not afford such things as regular newspapers. Similarly local radio and television programming tend to exclude most of the news of the outside world. Satellite access is available but is also expensive. The result is that few people know what is going on either in the world or in the Calgary area (where you're from).

Three of you decide to approach the company boss and see if the company will pay for the regular delivery of a newspaper. You place the request with your boss.

> *In exchange for the regular delivery of a newspaper, you will provide a weekly newsletter summarizing items from the newspaper that you feel most of your co-workers would want to see. The newsletter would then be distributed to all your Canadian co-workers using the company internal mail system.*

The company agrees providing the following conditions are met:

1. *The newsletter must provide for all the Canadians working at your location in roughly equal percentages (at least 80% Calgary content, 20% National content).*
2. *You may use company equipment to assemble and distribute the newsletter.*
3. *You* **may not** *use company time to assemble the newsletter.*
4. *Only one newspaper per week will be flown in (the Calgary Herald). You must decide which day would likely contain the most relevant news items and sections.*
5. *The newsletter must be no more than one page in length.*

6. *A sample newsletter must be submitted for approval before proceeding. The sample newsletter should give your boss an idea of what to expect in the real newsletters.*

You agree.

Using a combination of telephone and email you arrange a preliminary meeting between the three of you. As a group you decide that you need to do some planning. An agenda is agreed upon with the following items: (1) you need to come to an agreement about which day's newspaper to have flown in, (2) what sorts of items to summarize for the newsletter bearing in mind the constraints the company imposed, and (3) to produce a sample newsletter from an old Calgary Herald (in fact you were able to find three copies). Since this is on your own time, you all agree that you should spend no more than about 20 minutes on the first two items and 30 minutes on the third.

Unfortunately no two of you work in the same building. This means that a lunch hour meeting is out of the question. By the time some of you arrived at the same cafeteria, you would have to leave again.

Each of you decide to cheat the company a bit and leave for lunch early enough to meet in a central cafeteria. Although this will provide an opportunity to discuss the agenda items, there will not be more than about 20 minutes before each of you will have to return to your jobs.

You agree to meet electronically the day after your lunch meeting. The company provides adequate groupware (software for communicating with each other) so that you can assemble the newsletter on-line. Each of you will then be able to print a copy of the sample newsletter. One of you will submit the sample to your boss for approval.

Appendix B: Questionnaire

Instructional Design: Looking at distance communication alternatives.

Questionnaire - Part 1

There are two parts to this questionnaire. The first (this part) you will answer before beginning the study. The second questionnaire you will answer after completing the study.

Please answer all questions as best you can.

1. Please complete the following questions as best you can:

Age: ________
Sex: ________

Number of years of post-secondary education: ____________________
Current Area of Study (i.e. Psychology): ____________________

2. Do you own a personal computer? Yes No

Do you use it?

Always						Never
1	2	3	4	5	6	7

3. How many hours do you spend on a computer each week? ___________

4. Which platform are you familiar with (circle all that apply)? MacIntosh Win 3.1 Win 95 Unix

5. Computers are integral to my studies. True False

6. Have you ever participated in a group project as part of a **course** requirement? Yes No

How many times? ___________

7. Have you ever participated in a group project as part of a **job** requirement? Yes No

How many times? ___________

For each of the following statements indicate your agreement: 1 = strongly disagree, 2 = disagree, 3 = unsure, 4 = agree, 5 = strongly agree	1	2	3	4	5	6	7
1. I would rate myself as a computer expert.							
2. I would rather communicate with someone face to face than by telephone.							
3. If I could communicate with my instructor by email I would.							
4. I look forward to group projects.							
5. I am confident I can learn any computer program.							
6. I would prefer to do as much of my work on a computer as possible.							
7. More instructors should make themselves available by email.							
8. I would rather communicate with someone face to face than by computer.							
9. My experience with group projects has been positive.							
10. Chat groups provide a unique way to communicate with others.							
11. I have a good understanding of how computers work.							
12. Whenever I have worked in a group project the result has been better than I could have done on my own.							
13. I am comfortable using a computer.							
14. Group projects have been beneficial to me.							
15. Arranging meeting times with group members has never been a problem.							

Complete the following statements with the word or words that are the most accurate. 1 = very frequently, 2 = frequently, 3 = some times, 4 = rarely, 5 = never	1	2	3	4	5	6	7
16. I use a computer …							
17. The courses I have taken thus far have involved group projects …							
18. I use email …							
19. I participate in newsgroup discussions …							
20. I use database programs …							
21. I use word processing programs …							
22. I participate in chat sessions …							
23. I use spreadsheet programs ...							
24. I have participated in on-line group tasks …							
25. I participate in group projects …							
26. In my experience group projects have worked out well …							

Instructional Design: Looking at distance communication alternatives.

Questionnaire - Part 2

Please answer all questions as best you can.

Please circle one of the numbers below the question that you most agree with.

1. Overall the computer system we used in this study was adequate.

Strongly Disagree						Strongly Agree
1	2	3	4	5	6	7

2. Please indicate your reactions to the software used in this study:

Hard to Learn						Easy to Learn
1	2	3	4	5	6	7

Impersonal						Friendly
1	2	3	4	5	6	7

Frustrating						Not Frustrating
1	2	3	4	5	6	7

Time Wasting						Time Saving
1	2	3	4	5	6	7

Unproductive						Productive
1	2	3	4	5	6	7

For each of the following statements indicate your agreement: 1 = always, 2 = sometimes , 3 = unsure, 4 = rarely , 5 = never	1	2	3	4	5	6	7
1. How often did you get an impression of personal contact?							
2. How often were you able to express your views using the computer system?							
3. How often did you feel overloaded with information?							
4. How frequently did you feel held back in the types of contributions you could make?							
5. How frequently did you feel held back by the computer system?							
For each of the following statements indicate your agreement: 1 =strongly disagree, 2 = disagree , 3 = unsure, 4 = agree , 5 = strongly agree	1	2	3	4	5	6	7
6. The task we performed was easy.							
7. I enjoyed doing the task.							
8. Doing well in this task was important to me.							
9. I would like to do more group work using computers.							
10. This was a positive group experience.							
11. Communications tools such as those used in this study could improve group experiences.							
12. I would like to stay in touch with my fellow group members.							

Complete the following statements with the word or words that are the most accurate. 1 = very high, 2 = high, 3 = moderate, 4 = low, 5 = very low	1	2	3	4	5	6	7
13. The level of interaction between the participants was …							
14. Overall the level of interaction was …							

Appendix C: Hardware/ Software

Hardware - Software Specifications

Software

Client Computers (3)	Windows 95 operating system Teamwave v2.2 Client software
Server Computer	Linux operating system (Slackware v. 3.40) ** Teamwave v2.2 Server software

** Needed to use an older version's setup disks to do the initial set up because the newer ones crashed with this system. Once an installation was started it was possible to switch to the newer version's files.

Hardware

Client Computers (3)	Pentium 75 16 Mbytes of RAM 1 Gbyte harddrive PCI, 10baseT Ethernet cards 15" SVGA color monitors set to 800 X 600 resolution
Server Computer	486 DX 66 14 Mbytes of RAM 210 Mbyte harddrive ISA, 10baseT Ethernet card
Misc.	• 8 port hub and 10baseT cabling

Internet Resource Addresses

Linux (Slackware): http://www.cdrom.com/titles/os/slackwar.htm
Teamwave: http://www.teamwave.com

Appendix D: Experimental Protocol

In the following protocol any text within brackets are instructions to the experimenter.

[Each new group will be placed in either of experimental group 1 or 2 depending upon which experimental group was last used i.e. if the last group was group 1 then this group should be group 2]

1. Study Description

[The following will be read to the participants as a group.]

The study you are about to participate in has seven parts. It will take about two hours to complete all seven parts.

Part 1: Description of the study

Part 2: Complete a questionnaire that asks questions about your previous experience with group work, computers, and computer mediated communication.

Part 3: Computer training. You will be shown how to use the audio and the software used in this study.

Part 4: The project you will be completing during this study will be explained to you. Written instructions explaining your project will also be given to each of you. One of you may be videotaped during the process of completing the task. If the person assigned to the videotaping room would rather not be videotaped they may exchange the room with another. [If none of the participants wish to be videotaped an attempt will be made to reschedule with a different set of participants and the experimental session will be canceled]

Part 5: After you have completed the project to your satisfaction you will be asked to complete a second questionnaire.

Part 6: We will conduct a brief discussion regarding how you found the study.

Part 7: When the study is complete a short debriefing session will take place where you may ask any question regarding the study you would like to ask. You will then each be given $5 for your participation.

2. Ethics Review and Consent

As I mentioned earlier you will be filling out two questionnaires. The information contained in these questionnaires will be held confidential. Each questionnaire will be referenced by number only. No names will appear on the questionnaire. The data collected today will be stored in a locked cabinet in room A067. After approximately 5 years the data will be destroyed.

Your participation in this study is entirely voluntary. If you wish to withdraw from the study you may do so at any time. If you wish your data withdrawn from the study you may do so at any time. Should you decide to withdraw after beginning the study you will still be remunerated $5.

[pass out consent form to each participant]

Please read this consent form. Please pay attention to the study description. You may be videotaped and all of you will be audiotaped. Also note that you may be quoted from the audio or video. Please check the appropriate boxes on the consent form to indicate your agreement or disagreement with these. Lastly, I have provided a place on the consent form for your address or email address. If you would like me to let you know when I have the results ready for viewing, please indicate so by checking the box and entering the manner you would like to be contacted.

If you have any questions I will try to answer them when everyone is finished reading the form.

If you would prefer to withdraw from the study at this time please let me know.

When you are ready please sign and date the consent form.

Please note that you may keep a copy of the consent form if you wish.

3. Description of Study

This study is designed to look at groups working together when most or all of the communicating among group members is done using a computer. The project that is being used for this study is based on a cooperative learning technique called the Jigsaw technique where different parts of a project are divided up amongst group members and then later assembled into some sort of product. The group will need to get together at various times during the project in order to see where everyone is at. The final product will also be put together using the computer to help communicate with each other.

For the remainder of this study the only questions I will be able to answer will technical ones such as ‘how does the computer work?’.

The details of the project will be explained shortly. Are there any questions thus far?

[answer any technical questions]

4. Pre-Test

[number each questionnaire with the number of the group with subscript a, b, or c indicating which participant is which. Hand out the pre-test questionnaires to each participant]

Please fill out this questionnaire as best you can. Please try to answer all questions but remember you are under no obligation to do so. When you are finished turn your questionnaire over and wait until everyone is finished theirs.

5. Computer Training

[Take the participants to the lab computer and show them how to use Netmeeting. Try to have the program running before they come to the computer. Demonstrate how to use the whiteboard first and then demonstrate how to use the microphone.]

6. Project Description

[describe the task in detail. When appropriate to the group follow the directions either from the group 1 or group 2 dialog box. A copy of the following will be provided to each group member]

The product:

> Your group is part of an editorial team whose job it is to produce a two page summary of a daily newspaper. The final product will be this summary.

What to do:

Each group member will be given a copy of the Calgary Herald from which they will summarize articles based on topics of interest to the group. Choose a different topic for each group member to summarize. Topics are up to the group to determine. Perhaps begin with personal interests i.e. sports. Each group member will summarize the articles they select using one or two descriptive sentences. You may not, however, change the title of the article.

Producing the final product:

Once the articles have been selected and summarized the group must construct the final product. You will use the shared whiteboard for this part of the project. The final product must fit into two pages in the shared-whiteboard program. The group must decide on an appropriate layout for the summaries i.e. the layout of the articles on the screen. Because of the limited space (2 whiteboard pages) decisions will need to made regarding which articles to keep.

Project Completion:

When you are finished the summary pages leave the computers running and return to A067.

[the printed copy that each group member receives will contain the text from the matching condition as shown below]

[Group 1 - FTF]	[Group 2 - CMC]
To begin the task you will meet in person. When you have decided on topics and who is responsible for each topic, group members will go to his or her computer workstation and begin their part of the project. From that point until the completion of the project you will be using only the computer and the software provided to communicate with each other.	Each of you will be using a computer with which to communicate with each other and to assemble the final product. The first thing you will need to do once you have been shown to your computer workstations is to talk with each other using the computer and decide on the topics you will summarize and who is responsible for each topic.

7. Begin Task

[Group 1 - FTF]	[Group 2 - CMC]
Show the participants to the discussion table and ask them to begin part 1 of the task. At this time pass out a copy of the newspaper to each participant. When the group has completed part 1 of the task show each one into the computer rooms. Note the room number for each participant. Note: Room 1 is equipped with a video camera. The entire session as it is conducted in this room will be videotaped complete with audio. Explain to the participants that one of them will need to work in this room. They may choose amongst themselves who is to use this room. Make sure the computers are set up and running properly in each room. Ask the participants to begin and check each room in order. As each computer room is checked tell the participant that you will be in A067 in case there are any problems. Remind each participant to return to A067 when they are finished the task.	Show the participants into the computer rooms. Note the room number for each participant. Note: Room 1 is equipped with a video camera. The entire session as it is conducted in this room will be videotaped complete with audio. Explain to the participants that one of them will need to work in this room. They may choose amongst themselves who is to use this room. Make sure the computers are set up and running properly in each room. Ask the participants to begin and check each room in order. As each computer room is checked tell the participant that you will be in A067 in case there are any problems. Remind each participant to return to A067 when they are finished the task.

8. Post-test

[When the group is finished and has returned to A067 hand out the post-test questionnaires. Make sure the participant number is on each questionnaire.]

Please fill out this questionnaire as best you can. Please answer all questions. When you are finished turn your questionnaire over and wait until everyone is finished their questionnaire.

9. Discussion

[conduct a brief 15 minute discussion forum in A067]

There were a lot of things going on while you were building the newspaper summary. I'd like to take about 15 minutes and discuss what you thought about this study in particular and generally about using computers to do group projects on campus. I will be recording this discussion so that I can review your comments later.

[Turn on tape recorder and begin the discussion. Terminate it after 15 minutes]

10. Debriefing

[debrief the participants]

The purpose of this study is to determine the best way to organize a group project when the group members must use computers to communicate. It was hypothesized that people who were able to do the first part of a group project, the planning and task allocation, face-to-face would be more likely to be satisfied with the group experience than would people who do the same part using computers to communicate. Satisfaction is taken to be a measure of motivation – the more satisfied a person is with a learning experience the more likely they are to participate in a similar experience again.

This study is aimed at using computers to help make group projects possible particularly when group members have a hard time meeting with each other. The results should help to determine when group members may benefit from using the computer to communicate and when they may benefit from face-to-face meetings.

The study is expected to run until April, 1998. It will take several months to analyze all of the results so I don't expect to have anything to report until next spring. I will be contacting those of you who indicated on your consent form that you wished to know the results.

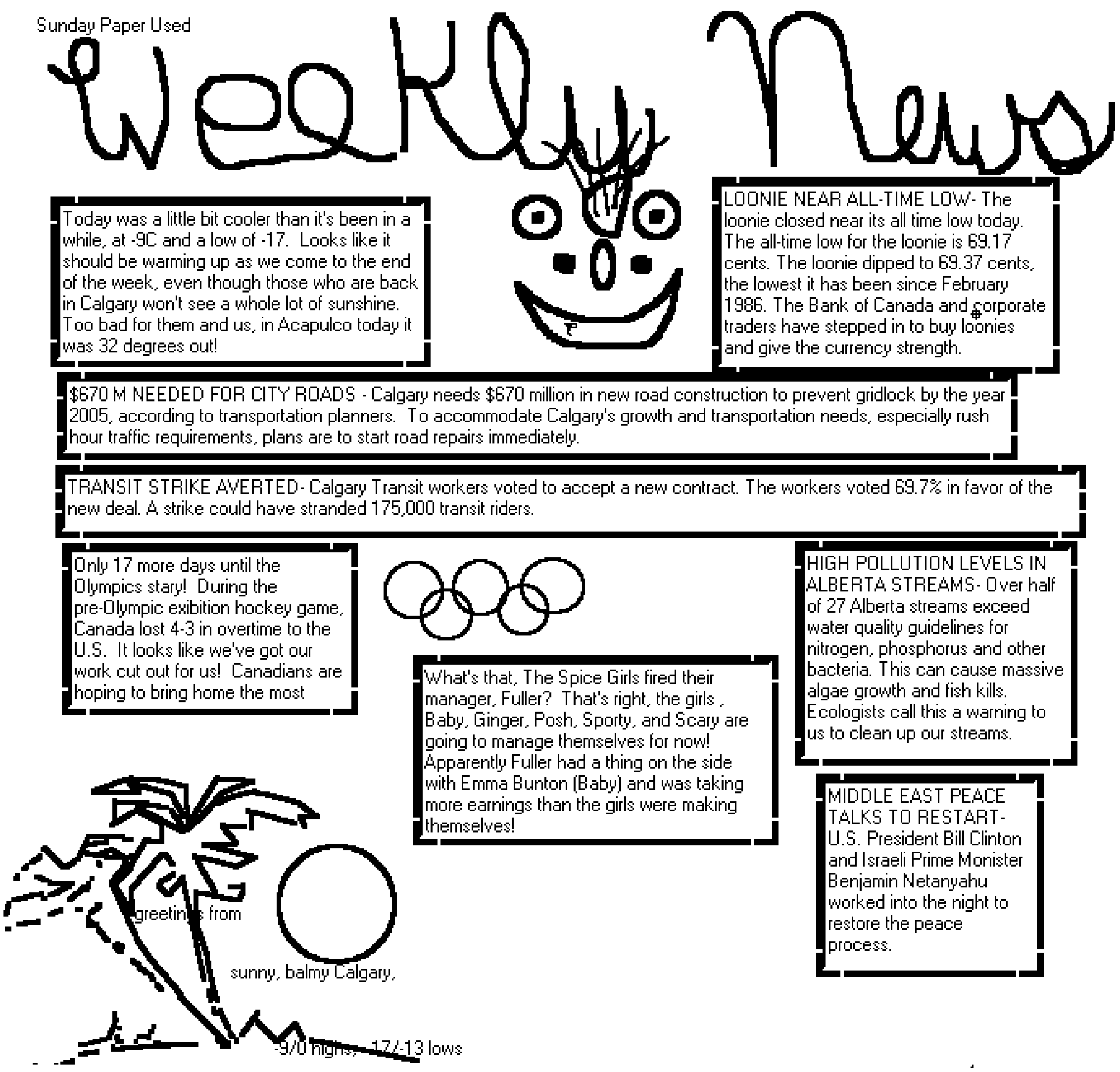
Do you have any questions or comments?

[answer questions, respond to comments]

11. Remuneration

[Pay each participant $5 and ask them to sign for receipt of the money. Thank each participant and show them out.]

Appendix E: Sample screens from completed newsletters.



Screen 1. This group attempted to add graphical elements to their newsletter, with a large degree of success.

CANADA WEEKLY NEWSLETTER

Friday, March 25, 1998

NATIONAL HEADLINES

Another Power Failure Hits Montreal: Hydro-Quebec said it ran into problems with a distribution line and at least 113,000 customers in east-end Montreal lost electricity.
Passengers Escape Injury as Plane Skids Off Runway: A commuter plane, originating in Calgary, skidded out of control and slammed into a snow bank when it landed at Lloydeminster city airport Tuesday night.
Tory Minister Held Grudge : Pocklington: Peter Pocklington accused a former Alberta cabinet minister Tuesday of holding a grudge against him for ignoring the minister's offer to sell him some Saskatchewan farmland.

SPORTS SCORES

HOCKEY		BASKETBALL	
National Hockey League		National Association	
Los Angeles 4	Calgary 3	Vancouver 88	Denver 77
Edmonton 6	Phoenix 2	Atlanta 103	Milwaukee 93
Chicago 5	NY Islanders 2	Portland 86	Cleveland 84

CALGARY HEADLINES

<13-YEAR-OLD CHARGED WITH MOM'S MURDER

13-year-old girl and boyfriend have been charged with first-degree murder of the girl's mother in a small Lethbridge suburb. Police answered a 911 distress call Monday at about 9:45pm. The girl and her boyfriend made a brief appearance in court Tuesday and will return on Thursday. Cause if death is yet to be determined.

<$670 M NEEDED FOR CITY ROADS

Calgary needs $670 million in new road construction to prevent gridlock by the year 2005. However, there is only $220 million in the capital city's budget. There are no plans to pump more provincial money into new projects.

<STUDY FINDS HIGH LEVELS OF POLLUTION

More than half of 27 Alberta streams in key agricultural production areas exceeded water quality guidelines for nitrogen, phosphorus, and disease -carrying bacteria a $4-million study had found. a 300-page report has found that phosphorus levels routinlely exceed Alberta's phosphorus standards of .05 mg/litre more than 80% of the time. Too much phosphorus can cause massive algae growhy and fish kills.

<'YES' VOTE AVERTS TRANSIT STRIKE

Calgray Transit workers voted i69.7 per cent in favour to accept a new contract Tuesday, extinguishing a strike threat that could have stranded 175,000 daily bus and C-train riders. The new deal brings great relief to those who rely on the transit system every day including 14,000 Catholic school students and 12,000 public school students.

<CRITICS TAKE AIM AT HUNTING, FISHING ID

An Alberta government plan to privatize the way hunting and fishing licences are issued will take money from conservation work and increase poaching, opponents warn. Beginning this spring, 500,000 hunters and anglers will be required to purchase a fie-year computerized identity cards at a cost of $8 before individual licences for hunting and fishing can be obtained

Screen 2: This group opted for a text-only presentation.

Appendix F: Frequency of Participants

Frequency of participants from each department.

Department	Frequency	Percent
Biology	2	3.12
Community Rehabilitation	2	3.12
Computer Science	2	3.12
Economics	1	1.56
Education	3	4.69
Educational Technology	3	4.69
English	1	1.56
French	1	1.56
General Studies	11	17.19
Humanities	1	1.56
Kinesiology	3	4.69
Philosophy	1	1.56
Pre-Dentistry	2	3.12
Pre-Med	1	1.56
Psychology	27	42.19
Science	2	3.12
Unclassified	1	1.56
Total	64	100.00