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# UNIVERSITY OF OKLAHOMA

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# GRADUATE COLLEGE

# COMPUTER-MEDIATED COMMUNICATION IN COLLABORATIVE WRITING

A Dissertation

# SUBMITTED TO THE GRADUATE FACULTY

in partial fulfillment of the requirements for the

degree of

Doctor of Philosophy

By

## AMI L. BARILE

Norman, Oklahoma

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# COMPUTER-MEDIATED COMMUNICATION IN COLLABORATIVE WRITING

A Dissertation APPROVED FOR THE

DEPARTMENT OF PSYCHOLOGY

BY

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Abstract

The purpose of this study was to determine if using computers to communicate during group writing tasks is an effective mode of communication. Three-person teams wrote term papers in one of the following media styles: face-to-face (FTF), synchronous computer-mediated communication (CMCS), or asynchronous computer-mediated communication (CMCA). The participants were given six weeks to complete the entire writing task. Indicators of performance, satisfaction, and process were measured. Results showed no performance differences across media styles in terms of group products. Satisfaction measures indicated low satisfaction for CMCA groups. General process measures showed that FTF and CMCS groups often behaved similarly, whereas CMCA groups did not. For example, CMCA groups had difficulties answering previously asked questions. Process measures specific to the task of writing showed similar results for all media types. The results suggest that CMCA may not be an appropriate setting for writing collaboratively; whereas groups collaboratively writing in a synchronous computer-mediated communication setting should be able to produce quality work satisfactorily.

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Computer-mediated communication in collaborative writing

Because businesses today are increasing their interest in networking computers among employees, work groups are now finding opportunities to include group members from various geographical locations. It, therefore, is becoming increasingly important to determine if computer-mediated communication (CMC) can be useful as a conferencing tool when people cannot meet face-to-face (FTF). This project is designed to determine if CMC is an effective form of communication in collaborative writing group task.

Many claim that it is unwise to expect groups to perform adequately without the opportunity to meet in person. One reason for skepticism is that people believe that when communicating in a CMC environment, there is lack of nonverbal and paraverbal cues that people need to communicate effectively. However, research suggests that there are advantages in removing nonverbal and paraverbal cues from communication. One advantage is that CMC groups tend to have more equal participation among group members than FTF groups.

For example, Siegel, Dubrovsky, Kiesler and McGuire (1986) conducted a series of experiments that varied types of CMC. In their first experiment, FTF groups were compared to anonymous CMC groups and non-anonymous CMC groups. All groups were given attractive risky-decision problems. The task was to reach consensus on the problem. Overall, both CMC groups demonstrated more equal participation among group members than FTF groups.

Another reason for skepticism in terms of CMC effectiveness is research that suggests that product quality is compromised in computer settings. For example, research shows that more CMC groups fail to reach consensus on problem-solving tasks than FTF

groups (Hiltz, Johnson, & Turoff, 1986). However, Walther (1996) points out that failure to reach consensus only occurs when groups are limited in the amount of time allowed to complete the task. When CMC groups are allowed to complete a task, product quality differences rarely occur.

Given the absence of product quality differences, it might appear that CMC is an effective form of communication. However, CMC research has shown that problems occur when using measures other than product quality. Dependent variables in CMC research fall into three general categories: product quality, process, and satisfaction (McGrath & Hollingshead, 1994). Process variables are measures that attempt to determine how the group performs during the task. Satisfaction variables are measures that assess the satisfaction of individual members for various aspects of group work including, but not limited to, satisfaction for the product, group members, and mode of communication. Research in CMC using measures of satisfaction and process often produce results indicating that CMC is not an effective means by which to perform group tasks (Siegel et al., 1986; Galegher & Kraut, 1994). Conclusions often indicate that lack of nonverbal and paraverbal cues make communication in computer settings difficult. However, it is possible that other factors, besides lack of nonverbal and paraverbal cues, are influencing CMC performance in satisfaction and process.

There are other factors worth considering when comparing CMC media types with FTF communication in terms of satisfaction and process measures. First, it is possible that lack of familiarity with CMC as a mode of communication has a detrimental impact on CMC users when measuring satisfaction for the various aspects of group work (Hollingshead, McGrath & O'Connor, 1993). Second, CMC as a means of

communication can be either synchronous (simultaneous) or asynchronous (sequential). Synchronous CMC may produce different results on the same process measure than asynchronous CMC (Hollingshead & McGrath, 1995). Third, the type of tasks the groups perform may influence CMC effectiveness in terms of process measures. CMC media may be an effective mode of communication for some types of tasks, whereas FTF may be better than CMC for other task types (Straus & McGrath, 1994).

#### Familiarity

Familiarity with a new mode of communication, such as CMC, may be the mitigating factor for satisfaction measures in CMC. Most often research tends to show that people are less satisfied with CMC when trying to communicate than people working in FTF settings. Galegher and Kraut (1994) found that when students write collaboratively for two weeks using CMC they have difficulty establishing relationships with other members of the group, thereby reducing satisfaction for the group project. Similarly, Galegher and Kraut (1990) found that although CMC satisfaction improved over a two week writing period, CMC groups had lower satisfaction ratings than FTF groups. However, satisfaction ratings when in a new form of communication, such as CMC, may take longer than in FTF situations because it takes time to become familiar with the new technology (Hollingshead et al., 1993).

For example, Bikson and Eveland (1990) conducted field research suggesting that satisfaction for perceived performance of group members improves for CMC users as a function of time. The study was conducted for one year using workers and retirees in a large corporation. The task was to develop the company's retirement policy. Two task forces were formed. Each group consisted of half workers and half retirees. One task force was given access to electronic communication, whereas the other group was confined to standard media forms. After a year of familiarization, electronic groups reported higher satisfaction in terms of evaluating their group's work performance than those using standard communication.

Likewise, Hollingshead et al. (1993) conducted a study lasting 13 weeks. The researchers found that satisfaction ratings tended to increase for CMC as a function of time. In fact, by the end of the study, there were no differences in some satisfaction scores between CMC and FTF groups. The present study will address the problem of lack of familiarity with CMC media by conducting a six week study.

#### Synchronicity

There are two main categories of CMC: synchronous (simultaneous) and asynchronous (sequential). Synchronous CMC is often referred to as real-time communication. An example of a synchronous situation is the chat rooms available through the Internet. People enter computer environments where other people are discussing issues. Anyone entering a room is allowed to contribute to the conversation.

Asynchronous CMC refers to sequential message exchanges over a period of time. The most common form of asynchronous CMC is electronic mail (email). Email is an electronic form of traditional mail, though it is faster than traditional mail. Email is similar to traditional mail because there exists a time lag between sending a message and receiving a reply. This lag is the most prominent distinction between synchronous and asynchronous computer communication. A lapse in time between messages allows for interruptions to occur, disrupting the flow of communication and for the messageresponse-message sequence to be violated. Therefore, people in synchronous computer settings have the advantage of communicating without long interruptions between messages.

The interruptions in the flow of communication may influence some process measures. Amount of coordination needed to complete a task is one type of process measure. In collaborative writing studies, Kraut and colleagues (Kraut, Galegher, Fish, & Chalfonte, 1992: Galegher & Kraut, 1994, Galegher & Kraut, 1990) used email and electronic bulletin boards (public messages) as the CMC setting. When compared to FTF, these asynchronous computer communication styles showed large deficits in coordination efforts among group members. Participants in the CMC condition reported having greater difficulty coordinating their work among group members than FTF participants. The authors concluded that coordination difficulties arise when groups attempt to write collaboratively in a CMC setting. However, it should be obvious that when comparing asynchronous CMC to synchronous FTF communication, one cannot determine whether differences in coordination efforts are due to differences in media style (CMC vs. FTF) or to the difference in synchronicity (synchronous vs. asynchronous).

In addition to coordination remarks, other process measures may be influenced by synchronicity. One such measure is number of irrelevant remarks. Irrelevant remarks are statements that address topics not related to the task. Research shows that synchronous CMC groups have a greater number of irrelevant remarks than FTF groups, whereas asynchronous CMC has fewer number of irrelevant remarks than FTF groups.

For example, Weisband (1992) examined process measures with synchronous CMC and FTF groups. In terms of task irrelevant remarks, CMC groups had a greater number of remarks than FTF groups.

On the other hand, Galegher and Kraut (1990) conducted an asynchronous CMC study for a collaborative writing task. Their results indicated that FTF groups had a greater number of irrelevant remarks than CMC groups. Comparatively, it would seem that synchronicity has an effect on whether or not groups spend time discussing topics other than the relevant task. However, without directly comparing synchronous to asynchronous CMC media under similar conditions, conclusions regarding irrelevant discussions in group work cannot be clearly determined.

Another message content measure that may be affected by synchronicity is attention given to previously asked questions. It is possible that interruptions in the flow of conversation make it difficult for those in an asynchronous CMC to specifically address questions posed by other group members. The present study will compare FTF groups with both synchronous and asynchronous styles of CMC communication in an effort to directly compare the two forms of CMC.

Task Type

Process measures such as coordination and irrelevant remarks are general conversation statements that apply to any group task. However, it is possible that some process measures are specific to certain subtasks within the larger task. For example, when writing collaboratively, the task begins with a brainstorming session where the group generates ideas for the topic of the paper. The next task for the group is to decide which topic to adopt. These two tasks are different in that the latter task is a decisionmaking task. The former task, generating ideas, does not require decision-making procedures.

Researchers have demonstrated that in an idea-generation task, people in a computer-mediated setting generally provide a greater number of ideas than people in a FTF environment (Jessup, Connolly, & Galegher, 1990; Gallupe, Dennis, Cooper, Valacich, Bastianutti, and Nunamaker, 1992; and Dennis & Valacich, 1993). These researchers posit that the reason for greater number of ideas produced in idea generation is due to the notion that people are free from production blocking when in a CMC environment. Production blocking refers to the situation where a person may have to stop and listen to someone else's ideas to keep up with the flow of conversation, causing the person to forget his or her own ideas. A computer-mediated environment alleviates this problem because there is a physical record of the conversation. Thus, a person can finish generating his or her own ideas and then attend to what others have said.

Tasks that require decision-making differ than idea-generation tasks in that consensus among group members is required. Research has demonstrated that CMC groups have difficulties reaching consensus (Hiltz et al., 1986; Siegel et al., 1986).

Straus and McGrath (1994) hypothesized that CMC will be a better fit for ideageneration tasks than for judgment (decision-making) tasks. Group members that would otherwise be suppressed by dominant group members in a FTF situation will contribute in a CMC setting. However, judgment (decision-making) tasks will be more difficult for CMC because consensus is required. Straus and McGrath confirmed these predictions. *Collaborative Writing* 

The present paper is intended to address CMC in a collaborative writing setting. The task was to produce a paper written by a three-member group. Little is known about the influence of CMC in collaborative writing. In order to determine whether CMC is

appropriate for such a task, we must look at the writing process itself. Writing for an individual involves three subtasks: planning, writing, and revising (Hayes & Flower, 1986). Furthermore, these tasks are not strictly sequential. There is a certain amount of overlap with each of the three tasks. For example, we usually revise as we write. Kraut et al. (1992) found the same processes occur during collaborative writing.

One way to determine the appropriateness of different types of CMC for collaborative writing is to address the three phases of writing separately. In spite of the overlap, these processes tend to have periods of concentration at different times during collaborative writing (Kraut et al., 1992) suggesting that a sequential dimension could be teased apart.

For the planning stage, subtasks may be affected differently depending on the style of communication. As discussed earlier, the process of generating topics for the main topic of the paper is an idea-generation task which may be well suited for CMC settings. However, the task of deciding what topic to adopt is different than a generate task in that consensus is required. Tasks requiring consensus may be better suited to a FTF setting as opposed to a CMC setting.

In terms of the writing stage, the appropriate writing strategy may depend on the type of media setting. Qualitative research (Posner & Baecker, 1993) suggests that there are six different writing strategies. For example, some groups split the writing of the first draft by section. On the other hand, some prefer to have one person write the entire first draft and then have each take turns revising. Tammaro, Mosier, Goodwin, & Spitz, (1997) point out that in collaborative writing most writing is done alone and then shared with other members. It is unknown whether the tendency to write alone is common for all

styles of communication. For example, synchronous CMC may afford writing together because a shared document can be viewed simultaneously while each member is in a private setting. A shared text editor can be sued as a collaborative till that would not be available when writing FTF. Collaborative tools in CMC environments may enhance CMC group work (Cummings, Schlosser, & Arrow, 1996). Much work needs to be done to determine the best writing strategy for a particular media type. Preferred writing styles may differ as a function of the communication setting.

In the revising stage, the task is to finalize the document. Making revisions is a decision-making task requiring consensus on the part of all of the group members. Revising the paper, therefore, is a task requiring leadership skills which may be difficult for CMC media types.

The present study examined the three stages of collaborative writing over a period of six weeks using three styles of communication: FTF, synchronous CMC (CMCS) and asynchronous CMC (CMCA). The paper addressed all three types of dependent measures for group work: product. satisfaction, and process. Furthermore, the process of group work was examined in terms of the behavior throughout the project, as well as behavior specific to each stage of writing.

## Product

Collaborative writing studies generally show that product quality does not differ between CMC and FTF (Galegher, & Kraut, 1990). Similarly, it is expected that product quality will be the same for a collaborative writing task regardless of media type.

#### Satisfaction

Satisfaction for the product, the media type, and relations with other members will be measured. It is expected that familiarity with the CMC influences satisfaction.

*Hypothesis 1*. Early in the task, CMCS and CMCA groups should show lower satisfaction measures than FTF groups. However, as familiarity with the new technology increases. satisfaction should improve for both types of CMC groups.

#### Process

There are two categories for process measures that will be addressed in the present study. The first category, general task measures, are measures that occur regardless of the type of task being performed. For example, group conversations can be coded for relevancy to the task no matter what task is being performed. The second category of measures are specific task measures. Specific task measures are those that are specific to collaborative writing. The number of revision statements is an example of a specific tasks measure.

Total number of statements that groups make is a general task measure that research has shown to favor FTF groups. Due to the effort in communicating through typed text in CMC environments, CMC groups tend to have shorter conversations than FTF groups (Daly, 1993; Hiltz et al., 1986; Kiesler & Sproull, 1992; and Straus & McGrath, 1994).

*Hypothesis 2.* CMCS and CMCA groups will have a lower total number of statements than FTF groups.

Equality of group members is a general task measure that research has consistently shown to favor CMC media. CMC groups are more equal in participation

than FTF groups. Equality of group members is believed to be affected by lack of nonverbal and paraverbal cues. According to Kiesler and Sproull (1992), when there are fewer nonverbal and paraverbal cues the status of an individual is harder to determine. Therefore, high status people do not dominate the conversation in CMC groups as is the case in FTF groups. Research that measures equality of participation compares synchronous CMC to FTF. If lack of nonverbal and paraverbal cues is the underlying mechanism for equality of participation, then CMCA group members should also be more equal in participation than FTF group members.

*Hypothesis 3.* FTF groups should show more inequality among group members than both CMCS and CMCA groups.

General task measures such as questions receiving attention, irrelevant remarks, indirect relevant remarks, and coordination remarks should be affected by synchronicity. Questions receiving attention refer to questions that are answered by group members. The notion of synchronicity suggests that FTF and CMCS groups should have an advantage over CMCA groups when answering members' questions. The disadvantage for CMCA groups is due to the idea that as the writing progresses, earlier questions may be forgotten or ignored for members in CMCA groups.

*Hypothesis 4*. FTF and CMCS groups should produce a greater proportion of questions that receive attention than CMCA groups.

For irrelevant remarks, research suggests that lack of synchronicity produces fewer number of irrelevant remarks for CMCA groups than FTF groups. However, there is no comparative study which compares CMCA groups to CMCS groups under similar conditions. Hypothesis 5. FTF and CMCS will produce more irrelevant remarks than CMCA groups.

Indirect relevant remarks are statements that are on-topic but are not intended to be incorporated as part of the paper. Little is known about how indirect relevant conversations are handled as a function of media type. Because these conversations do not involve decision-making behaviors, it is possible that indirect relevant conversations behave similarly to irrelevant conversations. Therefore, it is believed that indirect relevant remarks will be affected by sychronicity.

Hypothesis 6. FTF and CMCS will produce more indirect relevant remarks than CMCA groups.

The present study addresses coordination in terms of statements during discussions. Studies described by Kraut and colleagues (Kraut et al., 1992; Galegher & Kraut, 1994; Galegher & Kraut, 1990) use self-reports to establish coordination measures. Participants in the asynchronous CMC environment reported that CMC is a poor medium for establishing coordination. In the present study, number of coordination statements should be greater for CMCA groups than FTF groups if these groups are indeed having greater trouble coordinating their efforts. If asynchronicity is the cause of coordination problems, then CMCS group coordination remarks should be similar to FTF group remarks.

Hypothesis 7. CMCA groups should have more coordination statements than CMCS and FTF groups.

Some measures of process are specific to a particular writing stage and subtask within the writing process. For example, two content measures were taken during the planning stage only. These two measures were proposed paper topic statements and novel topic ideas. These tasks are related in content, but differ in process. Paper topic discussion statements involve decision processes because the group is attempting to decide what topic to eventually adopt as the theme of the paper. This task should be more difficult for both CMC groups because a consensus must be reached. Generating novel topic ideas, on the other hand, does not involve decision processes. This task is an idea-generation type measure. Therefore, consistent with the idea-generation literature, there should be an advantage for CMC groups over FTF groups.

Hypothesis 8. CMCS and CMCA groups should have more paper topic discussion statements than FTF.

Hypothesis 9. CMCS and CMCA groups should have more novel ideas than FTF groups.

One process measure that is concentrated in the planning stage but also evident throughout the writing process is decisions as to the content of the paper. These decisions should be difficult for both types of CMC groups because consensus is required.

*Hypothesis 10.* There should be more content decision statements for the CMC groups than for the FTF groups.

During the writing stage, groups tend to choose different writing strategies to complete the task. The scope of this project does not include direct manipulation of writing strategies. However, a descriptive analysis of the writing strategies that groups choose may suggest a propensity toward certain strategies as a function of media type.

Although most revisions occur during the writing stage, there is considerable overlap in terms of revisions during the various stages of the writing process. Therefore, revisions will be addressed across the entire writing process.

Hypothesis 11. There should be more revision statements in CMCS and CMCA groups than in FTF groups due to difficulties in reaching consensus.

## Method

## **Participants**

Students from a lower-division developmental psychology course at the University of Oklahoma were instructed to write a group term paper for course credit. Students were asked to volunteer to write their term papers under experimental conditions. Extra credit toward the final grade of the groups' term paper was given to those who volunteered. Ninety-nine participants from a course enrollment of 147 volunteered. Participants were randomly assigned to three-person groups forming 11 groups per condition<sup>1</sup>.

## Materials

Six times throughout the writing process, each person completed a questionnaire involving satisfaction of the product, coordination efforts, and group relations (see Appendix). Participants were instructed to mark the place on the line that represented their answer.

At the onset of the project, each group was given a problem-solving task to complete. The purpose of this task was to familiarize the students with the environment within which they would be working. The task was to determine the answer to a word problem from Novick (1988). Apparatus

*CMCS*. The CMCS groups met via computer terminals in an experimental laboratory. The laboratory consisted of three private rooms each equipped with a desk and a computer. These groups used Microsoft Netmeeting to conduct their meetings. Netmeeting is a group supported software affording users on-line discussion capabilities and a group supported text editor. All communications were recorded by the computer. Each member was trained to use the synchronous messaging system as well as the group text editor at the start of the first planning session.

*CMCA*. The CMCA group members used their personal email addresses to send messages to the group. Distribution lists were set up for each group such that when a message was sent to the group, each member and the experimenter received the message. All messages sent to the group were saved in the order in which they were received.

Before beginning the project, every member of the CMCA groups was given an individual training session with the experimenter. During the session, each group member was trained to: post personal messages through their personal email, attach files to email messages, and post public messages to the entire group through the distribution list.

*FTF*. The FTF groups met in a conference room. Meetings were recorded by video and transcribed to text. The video camera was in view of the participants. *Procedure* 

The group task was to write a term paper on a developmental psychology topic. Groups were allowed six weeks to complete the paper. Each stage of the writing process (planning, writing, and revising) was to take two weeks. In order to control the amount of time taken for each stage of writing, groups submitted products demonstrating their work

at the end of each writing stage.

The FTF and CMCS groups were asked to conduct a minimum of four meetings for each stage of the writing process<sup>2</sup>. At least two members of the group had to be present in order for the session to take place. The CMCA group members were instructed to send a minimum of four email messages to the groups before the end of each stage<sup>3</sup>.

At the first FTF and CMCS meetings, the problem-solving task was presented to the group. Groups were instructed to report to the experimenter when they believed they had the correct answer. Groups not finished at the end of 30 minutes were interrupted by the experimenter, given the correct answer, and instructed to proceed with the writing project.

The FTF groups received a type-written copy of the problem and blank paper to be used for calculations and notes if needed. The CMCS groups were presented the problem in the text editor on the computer. Each person in the group was shown how to manipulate the text and add notes to the text. They were also informed that any notes or changes made to the text would be viewed by the entire group. Furthermore, discussion of the problem was to be carried out in the on-line discussion portion of the software.

The problem-solving task was also posted to all of the CMCA groups as their first message. Each group member was instructed to post to the group at least one solution to the problem and then to proceed working on their paper.

At the end of the first meeting, CMCS and FTF group members received the satisfaction survey. Each person completed the survey in private rooms with no other group members present. CMCA groups received their first survey via email two days after the first group member submitted an email message. The survey was sent via email with instructions as to how to complete an electronic survey. Furthermore, members were instructed not to send the survey to the distribution list; rather to return the survey directly to the experimenter via a separate email address.

At the end of the first two weeks (the planning stage) all groups turned in an outline of their paper. In addition, all members were given another satisfaction survey to complete.

For the next two weeks (the writing stage) procedures were similar to the planning stage in that the students received satisfaction surveys at the beginning and end of the stage. The final product to be turned in at the end of the writing stage was a rough draft of the paper.

The final paper was due after the revision stage was completed. Again, surveys were completed at the beginning and end of the revision stage.

The groups were also instructed to refrain from discussing the project with other group members outside of the experimental conditions. Furthermore, groups were instructed to log any communications that occurred outside of the group setting. Logs revealed that few communications occurred. However, transcripts suggested that students met outside of meetings more often than reported in the logs. Most communications occurring outside of the group setting appear to have consisted of trading sections of the paper and reminding members to attend meetings.

#### Dependent Measures.

*Product Quality*. Product quality was measured by analyzing the output for each of the writing stages. The paper outline was scored for amount of detail and completeness. The rough draft was scored for length. Length was chosen as the quality

measure under the assumption that length represents completeness of the rough draft. The final paper was measured by the score received for the paper when the paper was graded by the course instructor. The instructor graded the final paper blindly. The method of blind grading was much the same as a blind review for publication. The students were instructed to have their names on the cover page only. The cover page was removed before grading the papers. In addition, papers from groups not participating in the project were included with the experimental papers when grading was conducted so that the grader did not know when she was grading an experimental paper.

Satisfaction Survey. Nine questions addressed issues such as satisfaction for product and group members. To obtain an overall satisfaction score, questions addressed the following issues in group writing: satisfaction for member relations (questions one through five), satisfaction for media style (question six), and satisfaction for the product (questions seven through nine, see Appendix).

*Process*. The following dependent measures were taken throughout the writing process:

1. Total number of statements. Total number of statements were coded for all conversations.

2. Equality of participation. Equality of group member participation was measured by obtaining the standard deviation of the number of member remarks in each group for the first and last sessions at each stage of writing, with higher standard deviations indicating less equal participation. Because CMCS groups do not have specific sessions where they come together to work on the paper, a method of equating periods of work with the FTF and CMCS conditions was needed. Therefore, comments from the first four days and the last four days of each writing stage for CMCA groups was considered the equivalent of the first and last session of each writing stage.

3. Questions receiving attention. All questions that receive follow-up statements were coded. If two participants addressed the question, only one answer was counted.

4. Irrelevant remarks. Statements that were off-topic were recorded. Irrelevant remarks that were excluded were comments such as greetings and salutations because these comments do not represent complete conversations that are off topic. All other comments not directly relevant to the paper were coded. Examples of irrelevant remarks include: "I had a job interview at 3:00..."; and "yikes, that car thing doesn't sound like too much fun."

5. Indirect relevant remarks. All statements that were on-topic, but not intended to be incorporated as part of the paper, were coded. Examples of indirect relevant remarks include: I also posted a messages asking for sources..."; and "...we have two weeks to write the rough draft."

6. Coordinating remarks. All statements that address issues such as division of labor ("I suppose ... I could do cognitive development) and plans for upcoming sessions ("... we need to come on Thursday with an outline...") were coded.

7. Proposed paper topic statements. All statements discussing the major topic of the paper during the planning stage were recorded. Examples of discussion items regarding the topic of the paper included statements such as: "I think mainstreaming would be a great topic if we can find enough info."; and "I looked through my book and found a few topics that may be interesting..." 8. Novel topic ideas. Number of novel topic ideas proposed during the planning stage were coded. Novel ideas consisted of only the first time a topic proposal was suggested. For example, the statement "I thought we could also think about the idea of mainstreaming..." was recorded as a novel idea; however, subsequent statements regarding mainstreaming were not counted.

9. Content decision statements. All statements regarding decisions of content and order of ideas throughout the writing process were measured. Examples of statements of this type are: "I think we need to define the meaning of the topic in a paragraph or two"; and "...the intro should just have the definitions and degrees of retardation."

10. Types of writing strategies. All messages addressing how the paper was to be written were classified as to type of writing strategy used. A descriptive analysis was used to determine if writing strategies differ as a function of media type.

11. Revision statements. Although no revisions were expected at the planning stage, some groups began revising during the writing stage. Therefore, revision statements were counted and analyzed for all stages of writing. Revision statements included any statements regarding changes to the rough draft. Changes could include semantic changes ("...but I found some things that are contradicting..."), structural changes ("I think we should add it in my part."), and copyedit changes ("...I only found one place that needed a comma...").

#### **Results and Discussion**

All analyses for the mixed-factorial design of Media Type X Writing Stage were conducted using the Wilke's Lambda test statistic for the multivariate analysis of variance (MANOVA) to control for assumptions of sphericity. Subsequent multiple comparisons

used alpha level .01 to control for Type I error. Subsequent analyses of stages of writing for each level of media type were done using Wilke's Lambda test statistic for a one-way MANOVA. To control for Type I error, the Bonferroni approach for multiple comparisons was used when testing media type differences at each level of writing. *Product Scores* 

*Outline*. Each outline was given a composite score consisting of three components. One point was received for each item in the outline. One point was given if the thesis statement was included in the outline. Finally, outlines were scored for level of specificity. For example, if only main ideas were provided a score of one was given; whereas if main ideas and one level of subtopics were provided a score of two was given. The three scores were then added together to produce one outline score for each group. Two CMCA groups failed to submit an outline and, therefore, were dropped from the analysis. Mean outline score for the FTF groups was 27.09. Mean outline scored for the CMCS group was 36.36. Mean outline score for the CMCA group was 31. A one-way ANOVA revealed no significant differences for outline scores by media type ( $F_{2,28} = 1.29$ , p > .05).

*Rough draft.* The rough draft was scored for length by producing a total word count for each document. Three CMCA groups failed to submit rough drafts and, therefore, were dropped from the analysis. Mean scores for length of rough draft by media type were as follows: FTF (M = 2662.27), CMCS (M = 2297.64), and CMCA (M =1643.13). The one-way ANOVA revealed no significant differences ( $F_{2,27} = 3.13, p >$ .05). *Final.* The criteria for the final paper grade consisted of: satisfactory completion of writing guidelines required in the course, depth of content, organization of information, and cohesiveness. Papers received from groups not participating in the experiment (N = 18) were included in the analysis to determine if an experimental bias existed. Elevated experimental paper scores could have indicated that the attention given to experimental groups influenced their performance. Mean grade for FTF groups was 28.36. Mean grade for CMCS groups was 27.18. Mean grade for CMCA groups was 28. Mean grade for non-experimental groups was 26.17. A one-way ANOVA revealed no significant differences ( $F_{3,47} = 1.11, p > .05$ ).

For product scores, the lack of product differences is consistent with most CMC research. However, it should be noted that although CMCA group products were similar to other groups, the CMCA condition was the only condition where groups failed to turn in outlines and rough drafts.

#### Satisfaction Scores

The satisfaction survey, consisting of nine questions (see Appendix), was administered twice for each writing stage. Responses were taken by measuring the number of total millimeters from the end of the response line to the participant's mark. Maximum score for each question was 130.

Means across all nine questions and the two surveys at each stage of writing were created to produce a single satisfaction score for each person at each level of writing. Participants failing to complete surveys at each stage of writing were dropped from the analysis. See Table 1 for means. MANOVA tests revealed a main effect for media type  $(F_{2,77} = 10.04, p < .05)$ , a main effect for stage of writing  $(F_{2,76} = 8.39, p < .05)$ , and a

significant interaction ( $F_{4,152} = 3.47$ , p < .05). One-way MANOVA tests for each level of media type across all levels of writing indicated FTF groups showed significant differences in satisfaction across stages of writing ( $F_{2,28} = 5.79$ , p < .01). Dependent t-tests assessing differences among stages of writing for FTF groups showed no significant differences at alpha level .01 suggesting that, although the one-way MANOVA revealed a significant effect. differences between stages of writing did not exist for FTF groups. CMCS groups showed significant differences across writing stages ( $F_{2,30} = 18.29$ , p <.01). Dependent t-tests assessing differences among stages of writing for CMCS groups showed that the planning stage was significantly lower than the writing stage ( $t_{32} = 4.70$ , p < .01): the planning stage was significantly lower than the revising stage ( $t_{32} = 3.52$ , p <.01). CMCA groups showed no significant differences. To determine differences in terms of media type for each stage of writing, the Bonferroni multiple comparisons tests revealed that CMCA had significantly lower scores than both CMCS and FTF at every stage of writing. No differences were found between CMCS and FTF (see Figure 1).

The prediction that satisfaction scores would begin low for both types of CMC groups improving over time has not been supported. CMCA groups maintained a consistent lack of satisfaction over all stages of writing. Although FTF groups and CMCS groups did not differ significantly at any stage of writing, only CMCS groups showed significant improvement in satisfaction over time.

The results showing that CMCS and FTF groups had similar scores from the beginning of the task to the end of the task is inconsistent with longitudinal research on satisfaction with CMC media. Research shows that CMC satisfaction begins lower than

FTF improving over time (Hollingshead et al., 1993). It is possible that only various aspects of satisfaction (i.e., satisfaction for group relations) reflect patterns of behavior similar to other research. In order to assess various aspects of satisfaction, the satisfaction survey was divided into three sections and analyzed separately.

Satisfaction for group relations was analyzed by creating a mean score of the first five questions in the survey. See Table 2 for means. MANOVA tests revealed a main effect for media type ( $F_{2.77} = 8.01, p < .05$ ), a main effect for stage of writing ( $F_{2.76} = 5.06$ , p < .05), and a significant interaction ( $F_{4.152} = 4.09, p < .05$ ). One-way MANOVA tests for each level of media type across all levels of writing indicated that only CMCS groups show significant differences across writing stages ( $F_{2.30} = 13.05, p < .01$ ). Dependent t-tests assessing differences among writing stage scores for CMCS groups showed that planning was significantly lower than writing ( $t_{32} = 3.85, p < .01$ ); planning was significantly lower than writing ( $t_{32} = 2.60, p = .0143$ ). To determine differences in terms of media type, the Bonferroni multiple comparisons tests revealed that CMCA had significantly lower scores than both CMCS and FTF at the writing and revising stages. No differences were found between CMCS and FTF (see Figure 2).

The pattern for satisfaction for group relations was similar to the overall satisfaction scores in that CMCS and FTF scores did not differ from each other. Furthermore, like overall satisfaction, CMCS groups were the only groups to show improvement over writing stages in group relation satisfaction. CMCA scores for satisfaction of group relations were similar to overall satisfaction except that CMCA scores were significantly lower than CMCS and FTF at the writing and revising stages only.

Satisfaction for media type was analyzed by comparing question 6 of the survey across media type and writing stage. See Table 3 for means. MANOVA tests revealed a main effect for media type ( $F_{2.77} = 7.23$ , p < .05), a main effect for stage of writing ( $F_{2.76} =$ 5.60, p < .05), and a significant interaction ( $F_{4,152} = 3.94$ , p < .05). One-way MANOVA tests for each level of media type across all levels of writing indicated there were no significant differences across writing stages for any media type at alpha level .01. To determine differences among media types for each level writing stage, the Bonferroni multiple comparisons tests revealed that FTF had significantly higher scores than both CMCS and CMCA at the planning stage; FTF had significantly higher scores than CMCA at the writing stage; and FTF and CMCS had significantly higher scores than CMCA at the revising stage (see Figure 3).

The pattern for satisfaction for media type differed from overall satisfaction. The results for media type satisfaction in terms of CMCS groups reflected the prediction that CMC groups would be less satisfied than FTF groups at the beginning of the task and improve over time. CMCS scores were significantly lower than FTF at the planning stage, but not at the writing or revising stages. CMCA groups, on the other hand, were significantly lower than FTF groups over the entire writing task. Furthermore, by the revising stage, CMCA scores were significantly lower than CMCS scores as well. The results for satisfaction of media demonstrated that when considering satisfaction for media type, familiarity will allow synchronous CMC group satisfaction for media type to become similar to FTF group satisfaction for media type. When in an asynchronous environment, satisfaction for the communication environment remains low.

Satisfaction for product was analyzed by obtaining the mean score for questions seven through nine of the survey. Means for satisfaction for product are in Table 4. MANOVA tests revealed a main effect for media type ( $F_{2,77} = 10.32$ , p < .05), a main effect for stage of writing ( $F_{2.76} = 13.19$ , p < .05). There was no significant interaction. A Tukey analysis of the between-subjects effect (media type) revealed that CMCA scores were significantly lower than both CMCS and FTF. The main effect for writing stages was analyzed using dependent t-tests at alpha level of .01. The t-tests revealed that planning was significantly lower than writing ( $t_{79} = 4.06$ , p < .01); planning was significantly lower than revising ( $t_{79} = 5.67$ , p < .01); and writing was significantly lower than revising ( $t_{79} = 3.02$ , p < .01; see Figure 4).

The pattern of results for satisfaction of product indicated that synchronicity is affecting attitudes toward the paper. CMCS and FTF groups do not differ from each other, whereas CMCA groups are consistently less satisfied with their product than CMCS and FTF groups.

## **Process Scores**

Total number of statements. Total number of statements for each group per writing stage were coded. See Table 5 for means. MANOVA tests revealed a main effect for media type ( $F_{2,30} = 24.09, p < .05$ ); a main effect for writing stage ( $F_{2,29} = 21.22, p < .05$ ); and a significant interaction ( $F_{4,58} = 5.62, p < .05$ ). One-way MANOVA tests for each level of media type across all levels of writing showed that were significant differences across writing stages for FTF ( $F_{2,9} = 9.24, p < .01$ ) and CMCS ( $F_{2,9} = 28.71, p < .01$ ). Differences across stages of writing for FTF groups were determined using dependent t-tests. The tests revealed that statements at the planning stage were significantly greater than statements at the revising stage ( $t_{10}$  = 3.66, p < .01). For CMCS groups, dependent t-tests revealed that statements at the planning stage were significantly greater than statements at the writing stage ( $t_{10}$  = 4.80, p < .01); and statements at the writing stage were significantly greater than statements at the revising stage ( $t_{10}$  = 7.50, p < .01). To determine differences among media types for each level writing stage, the Bonferroni multiple comparisons tests revealed that FTF groups had significantly higher scores that both CMCS and CMCA groups at the planning and revising stages. FTF groups had significantly higher scores than the CMCA groups at the writing stage (see Figure 5).

The tendency for FTF to have a greater number of total statements than CMC was expected. The interesting results were that each media type exhibited a different pattern as the groups progressed through the writing task. FTF groups showed a consistent decline in total number of statements. CMCS groups remained the same for planning and writing followed by a drop at the revising stage. CMCA groups stayed the same throughout the writing process.

*Equality of participation.* The standard deviation of the number of member remarks in each group was calculated in the following manner. Total number of words spoken per group member was obtained for the first and last session of each writing stage. The first and last sessions were then collapsed to form individual mean words for each stage of writing. Next, the standard deviation of the number of member remarks in each group was determined from the individual means at each writing stage. Higher standard deviation scores suggest less equal participation among group members. Mean standard deviation scores by media type for each writing stage are reported in Table 6. The MANOVA revealed a significant main effect for media type ( $F_{2,30} = 12.15$ , p < .05) and a significant main effect for writing stage ( $F_{2,29} = 5.24$ , p < .05). There was no significant interaction. A Tukey analysis of the between-subjects effect (media type) revealed that the standard deviation scores for the FTF groups were significantly higher than the CMCS groups and the CMCA groups (see Figure 6). The main effect for writing stages was analyzed using dependent t-tests at alpha level of .01. The t-tests revealed that the revising stage has more equality among group members than the writing stage ( $t_{32} = 3.27$ , p < .01).

In terms of equality of participation, the main effect for media type confirmed that CMC group members, whether synchronous or asynchronous, contribute more equally to group conversations than do FTF groups. This finding is consistent with other research (i.e., Siegel et al., 1986).

Questions receiving attention. Proportion scores of the number of questions that received an answer were obtained for each group at each stage of writing (see Table 7). The MANOVA revealed a main effect for media type only ( $F_{2,30} = 54.25$ , p < .05). A Tukey test for media type showed that both FTF and CMCS were significantly greater than CMCA (see Figure 7).

In terms of answered questions, the prediction was that CMCA groups would have lower proportion scores due to synchronicity. This prediction was confirmed. It would appear that interruptions in the flow of communication make it difficult for CMCA groups to attend to previously asked questions.

Irrelevant remarks. Total number of remarks not concerning the paper were counted at each stage of writing for each group (see Table 8). The MANOVA revealed a main effect for media type only ( $F_{2,30} = 9.66$ , p < .05). A Tukey test for media type showed that there were significantly greater number of irrelevant remarks for FTF than for CMCS or CMCA (see Figure 8).

As discussed earlier, previous research on irrelevant remarks makes predictions difficult. It was hypothesized that due to synchronicity FTF and CMCS groups would have greater number of irrelevant remarks than CMCA groups. In actuality, FTF groups discussed more irrelevant topics than both CMCS and CMCA groups. These results could be explained simply because FTF groups talked more than CMC groups as demonstrated by the analysis of total number of statements.

To determine if FTF groups are devoting more of their conversations to irrelevant remarks than CMCS or CMCA groups, proportion of total number of irrelevant remarks in terms of total statements was calculated (see Table 8) and analyzed. The MANOVA revealed a significant main effect for media type ( $F_{2,30} = 7.4$ , p < .05) and a significant main effect for writing stage ( $F_{2,29} = 5.61$ , p < .05). There was no significant interaction. A Tukey analysis of the between-subjects effect (media type) revealed that the proportion of irrelevant remarks for the FTF groups were significantly higher than the CMCA groups. The main effect for writing stages was analyzed using dependent t-tests at alpha level of .01. The t-tests revealed that the proportion of irrelevant remarks was significantly lower at the planning stage than at the writing stage ( $t_{32} = 2.96$ , p < .01).

Analysis of the proportion scores for irrelevant remarks revealed that there was greater proportion of irrelevant remarks for the FTF groups when compared to the CMCA groups only. These results suggest that there is a tendency for FTF to discuss more irrelevant remarks. However, lack of significant differences between CMCS and CMCA
groups suggest that synchronicity may not be the sole contributing factor when discussing irrelevant topics.

Indirect relevant remarks. The mean number of group indirect relevant remarks at each stage of the writing task for each media type are presented in Table 9. The MANOVA revealed a main effect for media type  $(F_{2,30} = 24.35, p < .05)$ , a main effect for writing stage  $(F_{2,29} = 11.30, p < .05)$ . and a significant interaction  $(F_{4,58} = 3.69, p < .05)$ . One-way MANOVA tests at each level of media type across all stages of writing showed significance across stages of writing for both FTF groups  $(F_{2,9} = 4.74, p < .01)$  and CMCS groups  $(F_{2,9} = 20.70, p < .01)$ . Subsequent dependent t-tests were used to compare each level of writing. Planning was significantly greater than revising  $(t_{10} = 2.79, p < .01)$  for FTF groups. Planning was significantly greater than revising  $(t_{10} = 4.94, p < .01)$  and writing was significantly greater than revising  $(t_{10} = 4.94, p < .01)$  and writing was significantly greater than revising  $(t_{10} = 4.94, p < .01)$  and writing was significantly greater than revising  $(t_{10} = 4.94, p < .01)$  and writing was significantly greater than revising  $(t_{10} = 4.94, p < .01)$  and writing was significantly greater than revising  $(t_{10} = 4.94, p < .01)$  and writing was significantly greater than revising  $(t_{10} = 4.94, p < .01)$  and writing was significantly greater than revising  $(t_{10} = 6.41, p < .01)$  for CMCS groups. The Bonferroni tests comparing media type showed that at the planning stage FTF was significantly greater than CMCS and CMCA. Additionally. CMCS was significantly greater than CMCA . At the writing stage, FTF was significantly greater than CMCA only. At the revising stage FTF was significantly greater than both CMCS and CMCA (see Figure 9).

Although the interaction for indirect relevant remarks reveals patterns that vary for the writing task as a function of media type, the data suggests that FTF groups tend to have a large number of indirect relevant remarks. It would be helpful to determine if FTF groups have more indirect relevant remark relative to their total relevant remarks than CMCS or CMCA groups. Proportions of indirect relevant remarks were obtained by dividing total number of indirect relevant remarks by the total number of relevant remarks. Mean proportion are shown in Table 9. The MANOVA revealed a main effect for writing stage ( $F_{2,29} = 11.27$ , p < .05) and an interaction ( $F_{4,58} = 3.58$ , p < .05). One-way MANOVA tests were used to determine difference across writing stages for each media type. FTF groups showed significant differences ( $F_{2,9} = 9.50$ , p < .01). Subsequent dependent t-tests showed that for FTF groups, planning was significantly lower than writing ( $t_{10} = 6.41$ , p < .01). The oneway MANOVA for the CMCS groups revealed a significant difference ( $F_{2,9} = 8.48$ , p <.01). Subsequent dependent t-tests showed that for CMCS groups, planning was significantly lower than revising ( $t_{10} = 6.41$ , p < .01). CMCA groups also produced significant differences ( $F_{2,9} = 18.41$ , p < .01). Dependent t-tests revealed that planning was significantly lower than revising ( $t_{10} = 6.41$ , p < .01); and writing was significantly lower than revising ( $t_{10} = 6.41$ , p < .01). The Bonferroni tests comparing media type showed no significant differences.

It was predicted that sychronicity would affect indirect relevant remarks in that CMCA groups should have significantly lower indirect relevant remarks than both FTF and CMCS groups. This prediction was not realized. Proportionally, none of the media types differed from each other.

Across writing stages, media types did show different patterns. CMCA groups consistently rise in terms of the proportion of indirect relevant remarks, whereas FTF groups show an increase from planning to writing only. CMCS also have low planning remarks; however, planning remarks do not differ from writing remarks. *Coordination remarks.* The mean number of coordination remarks at each stage of the writing process are presented in Table 10. The MANOVA revealed a main effect for media type ( $F_{2,30} = 4.40, p < .05$ ), a main effect for writing stage ( $F_{2,29} = 29.02, p < .05$ ), and a significant interaction ( $F_{4,58} = 4.71, p < .05$ ). One-way MANOVA tests at each level of media type across all stages of writing showed significance across stages of writing for FTF groups ( $F_{2,9} = 10.44, p < .01$ ) and CMCS groups ( $F_{2,9} = 24.54, p < .01$ ). Subsequent dependent t-tests were used to compare each level of writing. Planning was significantly greater than revising ( $t_{10} = 3.99, p < .01$ ) and writing was significantly greater than revising ( $t_{10} = 3.79, p < .01$ ) and writing was significantly greater than revising ( $t_{10} = 4.31, p < .01$ ) for CMCS groups. The Bonferroni tests comparing media type showed that differences occur only at the planning stage.  $\Gamma \Gamma F$  and CMCS are significantly greater in number of coordination remarks than CMCA (see Figure 10).

The prediction that the CMCA groups would have greater number of coordination remarks than FTF and CMCS groups was based on research that suggests that asynchronous groups report more difficulties in coordinating their work than FTF groups (Galegher & Kraut, 1994; and Galegher & Kraut, 1990). The actual number of coordination remarks is lower for CMCA groups than for either FTF or CMCS groups at the planning stage only. It is possible that the coordination difficulties of CMCA groups are occurring but are only evident in terms of the proportion of coordination statements in relation to all relevant discussions. Proportion of coordination scores were calculated in terms of total number of relevant remarks (see Table 10). MANOVA tests showed a main effect for media type  $(F_{2,30} = 3.89, p < .05)$  and a main effect for stage of writing  $(F_{2,29} = 15.52, p < .05)$ . There was no significant interaction. A Tukey testing for media type differences showed that CMCA had a greater proportion of coordination statements than FTF. Dependent t-tests for differences across writing stages showed that there was a greater proportion of coordination remarks at the writing stage than at the revising stage  $(t_{32} = 4.60, p < .01)$ .

Proportionally, CMCA groups do appear to be having difficulties in coordination. However, because CMCA and CMCS groups do not differ significantly, clear conclusions regarding synchronicity have not been established.

Proposed paper topics. All statements regarding choice of topic during the planning stage were counted. Means by media type are reported in Table 11. A one-way ANOVA revealed significance ( $F_{2,30} = 15.86$ , p < .05). Subsequently, a Tukey test determined that the FTF groups scored significantly higher than the CMCS groups and the CMCA groups. Proportion scores for proposed topic statements were calculated in terms of the total relevant remarks (see Table 11). The ANOVA revealed no significant differences.

These finding did not confirm the prediction that both CMC media types would have greater proposed paper topic conversations due to problems reaching consensus. Differences in total number of topic statements appears to be a function of the fact that FTF groups simply talk more. Proportionally, proposed paper topic statement discussion are similar for all media types. Novel topic proposals. Statements proposing new topics to be considered for the main topic of the paper during the planning stage were counted. Table 12 shows mean scores for novel topic proposals by media type. The one-way ANOVA was significant  $(F_{2,30} = 3.69, p < .05)$ . A Tukey analysis revealed that FTF groups scored significantly higher than CMCA groups. Analysis of proportion scores (see Table 12) revealed no significant differences among groups.

The prediction that both CMC media types would produce a greater number of topic choices was made based on research on brainstorming (Jessup et al., 1990; Gallupe et al., 1992; and Dennis & Valacich, 1993). However, the results of the present study do not support this prediction. Our results showed that proportionally no differences appear among groups.

Content decision statements. All statements addressing the contents of the paper during all three stages of writing were counted per group. See Table 13 for means. A MANOVA revealed a main effect for media type ( $F_{2,30} = 12.41$ , p < .05), a main effect for writing stage ( $F_{2,29} = 46.22$ , p < .05), and a significant interaction ( $F_{4,58} = 8.76$ , p < .05). One-way MANOVA tests for each level of media type across all stages of writing indicated significant differences across writing stages for every media type: FTF ( $F_{2,9} =$ 27.95, p < .01), CMCS ( $F_{2,9} = 20.05$ , p < .01), and CMCA ( $F_{2,9} = 11.03$ , p < .01). Dependent t-tests for FTF across stages of writing showed that planning was significantly greater than writing ( $t_{10} = 4.84$ , p < .01), and planning was significantly greater than revising ( $t_{10} = 7.88$ , p < .01). For CMCS, planning was significantly greater than revising ( $t_{10} = 5.87$ , p < .01), and writing was significantly greater than revising ( $t_{10} = 4.69$ , p <

.01). For CMCA, writing is significantly greater than revising ( $t_{10} = 3.63$ , p < .01). These

findings are expected. As the writing of the paper progress, fewer decisions as to the content of the paper are needed. The Bonferroni tests showed that FTF was significantly greater than CMCS and CMCA at the planning stage only (see Figure 11).

To determine if the results showing FTF scores were significantly greater than CMCS and CMCA were due simply to the fact that FTF groups talk more, proportion scores were calculated in terms of total relevant remarks (see Table 13). The MANOVA test revealed a main effect for writing stage ( $F_{2,29} = 31.86$ , p < .05). The main effect for media type and the interaction showed no significant differences. Dependent t-tests across writing stages showed that writing was significantly greater than revising ( $t_{32} = 4.60$ , p < .01).

Analysis of proportion scores revealed that there were no differences between groups as a function of media type. Differences in terms of total number of content decision statements appear to be due to that fact that FTF groups talk more. The prediction that problems reaching consensus would affect both types of CMC groups has not be supported.

*Types of writing strategies.* Information pertaining to issues of how to write the paper (i.e., division of labor) were extracted from the transcripts and categories of writing strategies were developed from the information. Basically, there were three strategies chosen to write the paper. The least common strategy used was to write the paper during meeting sessions, with each person contributing paragraphs at the appropriate time based on the research that the person had done. Only one group in each of the CMCS and FTF settings attempted this strategy. The second strategy used was to divide the paper into sections that each individual would write, except for the introduction and the conclusion

to the paper which was written together. Five of the FTF groups wrote the paper in this fashion; whereas nine of the CMCS groups wrote the paper this way. The third strategy was to divide the entire paper among the individuals including the introduction and the conclusion. Five FTF groups, one CMCS group, and all of the CMCA groups divided the complete paper into individual sections. Overall, for the FTF groups there seem to be no preference between writing all of the paper as individuals vs. writing some of the paper as a group. For CMCS groups there seems to be a tendency to write the paper as individuals except for the introduction and conclusion. The CMCA groups seemed to prefer to write the entire paper divided among individuals.

Although no inferential quantitative analysis was completed for the type of writing strategies selected by collaborative groups, some comments are worth noting. For CMCA groups only, the tendency to divide all sections of the paper among members was a better strategy than to try to write some sections together because of the lack of synchronicity in CMCA groups. Also, the fact that none of the experimental groups chose a single writer approach. as is sometimes the case (Posner & Baecker, 1993), was probably due to the fact that the paper was written for a course grade. Logs of each person's participation in the project were recorded by the group members to guard against free-riding. Participants may have been concerned with getting full credit for the paper and so, therefore, chose styles that would divide the writing evenly.

In addition to concerns for division of labor, choice of style may have impacted the quality of the final paper. To test this idea, an analysis of the final paper scores was conducted as a function of type of writing strategy used. Two strategies were used for the analysis: writing individually and writing some portions as a group. The strategy to write the entire paper during meeting sessions was excluded because only two groups chose this strategy. The mean final paper scored for groups writing individually was 28.18. The mean final paper score for groups writing some portions together was 27.14. An ANOVA revealed no significant differences for final paper scores as a function of writing strategy used ( $F_{1,29} = 0.50$ , p > .05).

*Revision statements.* Revision statements were counted at all stages of writing (see Table 14). The MANOVA revealed a main effect for media type ( $F_{2,30} = 3.84$ , p < .05), and a main effect for stage of writing ( $F_{2,29} = 6.92$ , p < .05). There was no significant interaction. The Tukey test for media type differences showed that FTF is significantly greater than CMCA. Dependent t-tests for writing stage differences showed that planning is significantly lower than revising ( $t_{32} = 3.33$ , p < .05).

Proportion scores for revision statements in terms of all relevant remarks were calculated (see Table 14). The MANOVA tests revealed a main effect for media type  $(F_{2.30} = 3.64, p < .05)$ , and a main effect for stage of writing  $(F_{2.29} = 10.47, p < .05)$ . The Tukey test for media type differences revealed that although the MANOVA produced a significant main effect, no media types were significantly different from one another. Dependent t-tests to determine differences in writing stages revealed that planning was significantly lower than revising  $(t_{32} = 4.27, p < .01)$ , and writing was significantly lower than revising  $(t_{32} = 3.52, p < .01)$ . Results showing increases in revision statements as the writing process progresses are expected. As writers approach completion of the paper more revisions are needed.

The fact that FTF groups have a greater number of revision statements than CMCA groups does not support the hypothesis that consensus-reaching tasks would be difficult for CMC groups. The proportion of revision statement analysis demonstrating there are no media differences also fails to support the prediction. The prediction that problems reaching consensus in revising would differentially impact media type has not been supported.

#### General Discussion

This paper discusses three factors that may be influencing behavior in CMC: familiarity. synchronicity, and task type. Familiarity was proposed to affect satisfaction. Synchronicity was predicted to influence general process measures. Task type was believed to affect specific process measures.

Familiarity appears to affect satisfaction only when in a synchronous CMC setting. Furthermore, familiarity appears to affect CMCS only when assessing satisfaction for media type. CMCS satisfaction for group relations and product are indistinguishable from FTF. In addition to familiarity effects, synchronicity appears to have an impact on satisfaction scores. CMCA scores were consistently lower than both CMCS and FTF scores.

Synchronicity also appears to have an impact on some general process scores. Synchronicity effects are clearly evident when measuring questions that receive attention. CMCA groups have lower proportion scores for questions receiving attention than both FTF and CMCS groups. Synchronicity may be impacting coordination scores and irrelevant remarks. However, the effects are not always clear.

Proportionally, CMCA groups discussed coordination more than FTF suggesting that CMCA groups did have trouble coordinating their work. However, CMCS scores did not differ significantly from either FTF or CMCA groups. Synchronicity may be helping CMCS groups in their coordination efforts but not enough to lower their scores significantly below that of CMCA groups. It is possible that text-based communication, such as CMCS, could be making coordination more difficult.

Another possible reason that CMCS group scores were not more similar to FTF group scores could be that communicating from remote locations could be increasing coordination remarks. If remoteness is contributing to coordination problems, rather than the textual basis of CMCS, then any technology supporting remote collaboration (i.e., videoconferencing) would exhibit more coordination remarks than FTF communication.

The general process measure of irrelevant remarks, like coordination remarks, shows that FTF and CMCA proportion scores are significantly different from each other; whereas CMCS scores fall in the middle, not differing significantly from either FTF or CMCA scores. Like coordination remarks, synchronicity could be contributing to the discussion of irrelevant remarks, but not enough to create significant differences between CMCS and CMCA. It seems likely that the reason that irrelevant remarks for CMCS groups are not more similar to FTF groups is due to the textual basis of CMCS. However, it is unclear whether CMCS groups reduce their number of irrelevant remarks due to the effort needed to write in text format or due to the lack of nonverbal and paraverbal cues inherent in FTF communication that may promote off-topic conversations. In any case, synchronicity appears to be mitigating some of the results for general process remarks.

For specific process measures, task type appears to have little or no influence as a function of media type. In terms of frequency of remarks, it appears that FTF groups are outperforming both CMCS and CMCA groups. However, these differences appear to be due simply to the fact that FTF groups talk more. Proportionally, there are no differences

between media type for idea-generation tasks or consensus-reaching tasks.

The idea-generation task of producing novel ideas for the topic of the paper showed no differences in terms of media type when measured by proportion. As explained earlier, these results are surprising in that there is considerable research showing that CMC groups generate more ideas than FTF groups. It is possible that because the task of generating topics is a subtask of the complex writing task, groups failed to recognize generating topics as an explicit idea-generation or brainstorming task.

Consensus-reaching tasks such as paper topic discussions, content decision proposals, and revision statements were predicted to be more difficult for CMC groups due the problems CMC groups have reaching consensus. Problems in reaching consensus should have produced a greater number of remarks. However, proportionally, none of the consensus-reaching measures varied as a function of media type. The lack of differences could be due to the type of group work. Collaborative writing promotes a considerable amount of individual work (Tammaro, Mosier, Goodwin, & Spitz, 1997) for each member of the group. The large amount of individual work in collaborative writing probably reduces the amount of consensus needed as compared to other types of group work where more conflict resolution is required..

Considering the results overall, it seems apparent that despite lack of product differences, CMCA is not an effective means for writing collaboratively. CMCA groups had trouble throughout the entire writing process. Interruption in flow of communication (synchronicity) seems to be a large contributor to CMCA group problems.

When synchronicity is not afforded in communication, problems arise in terms of satisfaction. CMCA groups produce low satisfaction scores when evaluating group

relations, media type, and product. In addition, CMCA difficulties are apparent in some process measures such as coordination and questions receiving attention.

When the communication style affords synchronicity, CMC groups behave similarly to FTF groups. For example, satisfaction for group relations and product quality do not differ. In addition, some process measures, such as questions receiving attention, are similar.

In general, conclusions suggest that the main purpose of this study have been realized. The original goal was to determine if CMC is an effective mode of communication for collaborative writing. It has been demonstrated that although asynchronous communication may not be an appropriate method of collaborative writing, groups writing in a synchronous CMC setting will produce good quality work, satisfactorily and without serious writing process difficulties.

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#### Footnotes

<sup>1</sup>Eight volunteers failed to complete the study. Groups with drop-outs completed the study with only two members. Three FTF groups, one CMCS group, and four email groups were two member groups upon completion of the study.

<sup>2</sup>For FTF groups there were four times when groups met for only three sessions of the required four. For the CMCS there were nine times that groups met for only three sessions. In addition, one FTF group met for an additional session during the writing stage of the study.

<sup>3</sup>Only four participants met this criterion for all stages of writing.

#### Appendix

Please complete the following questionnaire by marking the line in the place that represents your answer. 1. How much time did you spend scheduling with the other group meriders?

Very little		Average	<u> </u>	Too Mu
2 [ clearly und	erstand what my ta	- sks were		
2. I CICALLY UND		JRJ WEIC.		
Strongly		No Opinion	Disagree	Strongly
Agree	Agree		Disagree	Disagree
3. I clearly und	erstood what the ot	her group members' t	asks were.	
Strongly	Agree	No Opinion	Disagree	Strongly
Agree				Disagree
4. All members	in my group contri	ibuted equally in the v	workload.	
	·			
Strongly	Agree	No Opinion	Disagree	Strongly
Agree				Disagree
Strongly	Agree	No Opinion	Disagree	Strongly
Agree				Disagree
Strongly Agree	Agree	No Opinion	Disagree	Strongly Disagree
7. I am satisfied	l with the overall qu	ality of the paper thu	s far.	
1	I	I	1	I
Strongly	Agree	No Opinion	Disagree	Strongly
Agree	-	-	-	Disagree
B. I am satisfied	l with the organizat	ion of the paper thus	far.	
1	1	1	T	1
Strongly	Agree	No Opinion	Disagree	Strongly
Agree		<b>F</b>		Disagree
- ) I am satisfied	with the content of	f the naner thus far		-
. I UIII JULIJIIGU		puper unus tat.		
12000013/	A	M = O = 1 = 1 = 1		C
Subligiy	Agree	No Opinion	Disagree	Strongly

# Mean Satisfaction Scores for Each Stage of Writing as a Function of Media Type.

	Media Type		
riting Stage	FTF	CMCS	CMCA
	N = 30	N = 32	N = 18
			·
Planning Session	89.73	85.22	74.94
Writing Session	94.15	92.94	76.00
Revising Session	94.82	98.97	74.05

Mean Satisfaction For Group Relation Scores for Each Stage of Writing as a Function of Media Type.

	Media Type			
Writing Stage	FTF	CMCS	CMCA	
	N = 30	N = 32	N = 18	
<b></b>				
Planning Session	90.54	88.48	81.11	
Writing Session	94.55	96.03	79.55	
<b>Revising Session</b>	92.78	101.51	80.12	

Mean Satisfaction for Media Type Scores for Each Stag? of Writing as a Function of Media Type.

	Media Type			
Writing Stage	FTF	CMCS	СМСА	
	N = 30	N = 32	N = 18	
·			<u> </u>	
Planning Session	88.92	66.72	64.48	
Writing Session	89.22	68.55	58.97	
Revising Session	85.74	70.10	38.64	

# Mean Satisfaction for Product Scores for Each Stage of Writing as a Function of Media

Туре.

Media Type		
FTF	CMCS	CMCA
N = 30	N = 32	N = 18
		<u> </u>
88.65	85.94	68.14
95.14	96.04	75.92
101.23	104.35	75.69
	FTF N = 30 88.65 95.14 101.23	Media Ty           FTF         CMCS           N = 30         N = 32           88.65         85.94           95.14         96.04           101.23         104.35

# Mean Total Number of Statements for Each Stage of Writing as a Function of Media

Type.

	Media Type		
Writing Stage	FTF	CMCS	СМСА
Planning Session	1055.5	408.1	152.7
Writing Session	754.7	465.7	172.4
Revising Session	563.2	229.8	152.2

Mean Standard Deviation of the Number of Group Member Remarks by Media Type and Writing Stage.

Writing Stage	Media Type		
	FTF	CMCS	СМСА
Planning Session	493.65	80.51	130.51
Writing Session	397.35	151.65	196.80
<b>Revising Session</b>	374.31	53.00	112.29

# Mean Proportion of Questions Receiving Attention as a Function of Media Type and

	1				
	<u></u>	Media Type			
Writing Stage		FTF	CMCS	CMCA	
Planning Session		.87	.80	.39	
Writing Session		.91	.78	.39	
<b>Revising Session</b>		.91	.77	.44	

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Writing Stage.

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# Mean Irrelevant Remarks by Media Type and Writing Stage.

	Media Type		
Dependent Measure	FTF	CMCS	СМСА
Total Statements			
Planning Session	97.91	6.91	2.64
Writing Session	85.91	35.09	2.55
Revising Session	53.64	16.36	2.09
Proportion			
Planning Session	.08	.02	.02
Writing Session	.12	.07	.01
<b>Revising Session</b>	.09	.06	.01

# Mean Indirect Relevant Remarks by Media Type and Writing Stage.

	Media Type			
Dependent Measure	FTF	CMCS	CMCA	
Total Statements				
Planning Session	783.64	322.36	118.09	
Writing Session	601.90	366.40	147.50	
<b>Revising Session</b>	455.00	147.50	138.64	
Proportion				
Planning Session	.81	.80	.70	
Writing Session	.91	.86	.86	
<b>Revising Session</b>	.87	.87	.92	

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# Mean Coordination Remarks by Media Type and Writing Stage.

	Media Type		
Dependent Measure	FTF	CMCS	СМСА
Total Statements			
Planning Session	28.36	22.00	8.27
Writing Session	30.09	29.36	13.91
<b>Revising Session</b>	8.64	8.64	8.45
Proportion			
Planning Session	.03	.06	.07
Writing Session	.05	.07	.09
Revising Session	.05	.04	.02

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# Mean Proposed Paper Topics by Media Type and Writing Stage.

Dependent Measure		Media Type		
	FTF	CMCS	CMCA	
Total Statements		<u> </u>		
Planning Session	51.36	14.24	7.60	
Proportion				
Planning Session	.06	.05	.13	

# Mean Novel Topic Ideas by Media Type and Writing Stage.

Dependent Measure	Media Type			
	FTF	CMCS	CMCA	
Total Statements				
Planning Session	7.18	5.36	3.46	
Proportion				
Planning Session	.01	.02	.03	

# Mean Content Decision Statements by Media Type and Writing Stage.

Dependent Measure	Media Type		
	FTF	CMCS	CMCA
Total Statements			
Planning Session	94.27	36.18	16.82
Writing Session	27.55	24.45	7.73
Revising Session	7.91	5.36	1.54
Proportion			
Planning Session	.10	.09	.10
Writing Session	.03	.05	.05
Revising Session	.03	.01	.01

#### Mean Revision Statements by Media Type and Writing Stage.

Dependent Measure	Media Type		
	FTF	CMCS	CMCA
Total Statements			
Planning Session	0	0	0
Writing Session	9.27	10.46	0
<b>Revising Session</b>	38.00	15	1.45
Proportion			
Planning Session	0	0	0
Writing Session	.01	.02	0
<b>Revising Session</b>	.08	.07	.01

#### Figure Caption

Figure 1. Mean satisfaction scores by media type and by stage of writing.

Figure 2. Mean satisfaction for group relations scores by media type and by stage of writing.

Figure 3. Mean satisfaction for media type scores by media type and by stage of writing.Figure 4. Mean satisfaction for product scores by media type and by stage of writing.Figure 5. Mean total number of statements for each stage of writing as a function of media type.

Figure 6. Mean standard deviation of the number of group member remarks by media type and writing stage.

Figure 7. Mean proportion of questions receiving attention as a function of media type and writing stage.

Figure 8. Mean number of irrelevant remarks for each media type by writing stage.
Figure 9. Mean number of indirect relevant remarks for each media type by writing stage.
Figure 10. Mean number of coordination remarks for each media type by writing stage.
Figure 11. Mean content decision statements as a function of media type and writing stage.

Figure 12. Mean number of revision statements by media type and writing stage.










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