

# A Comparative Content Analysis of Face-To-Face vs. ALN-Mediated Teamwork

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## Abstract

*This paper presents the content analysis results of a field experiment comparing manual groups with groups using an Asynchronous Learning Network (ALN) to discuss and solve a case study. Findings show that ALN-mediated groups had broader discussions and submitted more complete reports than their manual counterparts. There was no difference in the ability to transfer information from the discussion to the report, in both conditions about 15% of issues mentioned in the discussion were omitted from the final group report. In terms of coordination, face-to-face teams covered the case study questions sequentially and efficiently, like items on a meeting agenda. Asynchronous groups were more focused on solving their general disagreements than on the worksheet questions and adopted parallel and pooled coordination strategies to put together the report.*

## 1. Introduction

In the last two decades, the literature in computer-mediated group communication includes a growing number of empirical studies comparing traditional "face-to-face" groups with electronically supported teams solving idea generation or decision-making tasks (for a meta-analysis see [17] and for a recent review see [6]). Most of these empirical studies present statistical measures of the outcomes produced by the groups and individual perceptions of the process, without analyzing in depth the process whereby the groups arrived at their decisions or produced their outcome (for exceptions see [20] and [24]).

The principal causes of successful and unsuccessful decision-making can be traced to the content of the interaction that precedes the decision [11]. However, despite the availability of data, content analyses of computer-mediated communication are rarely conducted [18] [20]. The study reported in this paper seeks to fill this gap in the literature.

Another characteristic shared by most of the empirical research conducted to date is the comparison between synchronous computer-mediated groups working in decision-making rooms and manual unsupported teams

interacting "face-to-face." The use of asynchronous technologies such as email, threaded discussions and computer conferencing to support teamwork has not been studied to the extent of synchronous systems [6]. This project also intends to make a contribution in this direction, by comparing asynchronous online groups with traditional manual teamwork.

The study of asynchronous teamwork is critical due to the exponential growth of the Internet and the emergence of Asynchronous Learning Networks (ALN). Today, asynchronous computer-mediated communication systems tailored to support educational activities are being increasingly used to complement or replace traditional learning environments [8]. The use of ALNs to support group work poses interesting research questions. How is a face-to-face discussion different from an asynchronous text-based exchange of ideas? What is the effect of these differences on the final outcome?

The main objective of the research project is to study the effects of ALNs on groups and individual students. The analysis of learning outcomes is reported by [3], and a more complete summary of the project can be found in [2]. This paper is focused on the content analysis of the discussions and final reports of ALN-supported and face-to-face groups of students solving a computer ethics case. The premise is that content studies of group communication offer additional insights to explain differences in outcomes, and develop recommendations to improve asynchronous interaction.

To this end, the remainder of this paper proceeds as follows. Section 2 lays out the theoretical foundations, and presents the research framework and the hypotheses. Section 3 describes the methodology and the experimental procedures. Section 4 describes the content analysis and findings. Section 5 discusses the implications of the results and the limitations of the study. Finally, section 6 concludes the paper.

## 2. Research Framework and Hypotheses

The solution of case studies in groups can be conceptualized as a two-step process: discussion and solution. In the discussion phase, students exchange ideas and opinions about how to solve the case and agree on a

course of action or set of recommendations. The solution or decision is usually communicated through a written report, which documents the results of the group discussion. Through this process the group must decide how to coordinate the efforts of its members and how to transfer the content of the discussion to the final report.

Traditional face-to-face verbal discussions suffer from a number of process losses such as air-time fragmentation, blocking, evaluation apprehension, domination and free-riding [13]. Communication software for group discussion is aimed at increasing process gains and reducing process losses.

The use of a computer-mediated communication system affects the nature of group discussions due to the inherent differences between verbal and asynchronous text communication. Although asynchronous communication could be more efficient in promoting more carefully worded comments or more balanced participation, it could be less desirable due to the difficulty of conceptually integrating divergent contributions in order to produce the expected outcome [13].

Asynchronous use of computer-based group support tools and processes represents a *unique mode of communication*, different not only from face-to-face communication, but even from synchronous group support systems or other forms of computer support [19]. Asynchronous use leads to different communication behavior and to unique coordination problems and opportunities [8], [22].

In an asynchronous environment, a group member can contribute whenever s/he has a useful input. Participation is not constrained to specific times and places. Users are free from temporal and geographical constraints because they do not have to be on the system simultaneously to send or receive messages [19]. In addition, each individual may focus her/his efforts on the part of the problem that s/he feels better qualified to address. This means that any participant could voluntarily spend a given amount of time on any part of the problem [22]. There is also the possibility of greater flow of communication given the ability to upload and download from personal computers and to search or browse through items at a relatively rapid pace [9].

ALNs tend to promote richer discussions than face-to-face exchanges but pose additional coordination challenges to team members working in this environment. There are five different coordination approaches that groups may employ in order to manage the flow of work [23]. These strategies are presented below in order of increased interdependence.

1. *Parallel*: group members engage in modular sub-tasks that require little or no synchronization.
2. *Pooled*: the whole group may need to cooperate in a loosely coupled fashion to develop a collective group output by combining the outcomes of the parallel

activities. In this approach, interdependence among the activities is low, but not all of the activities can be performed in a pure parallel mode at the individual level.

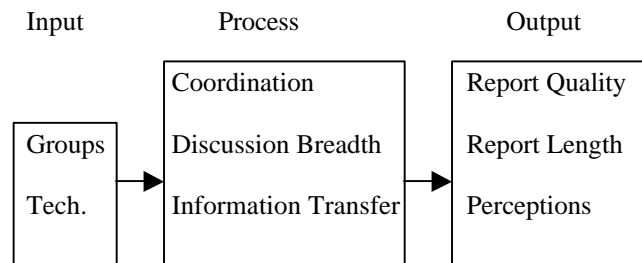
3. *Concurrent*: group members work together and interact in a tightly coupled mode.
4. *Sequential*: the group implicitly or explicitly adopts a plan of action and sequentializes the work process. Some of the activities require that they be taken care of before moving on to the next set of activities.
5. *Reactive/Reciprocal*: the task involves very high levels of interdependence in terms of the effects of previously performed activities and external events. The order of occurrence is not predictable in time, but event oriented.

Coordination needs are minimal for parallel and pooled approaches and maximum for reactive/reciprocal modes. Groups without a history of working together tend to select their coordination strategy ad-hoc, based on the constraints of the communication medium and the demands of the task.

One of the basic premises put forth here is that superior outcomes are possible in ALN-supported teams because the medium allows team members to have better discussions than groups carrying out traditional verbal discussions. ALNs also provide members with an automatic transcript of the communication, which facilitates the transfer of information to the final report.

A computer-mediated communication medium provides an environment where richer discussions can take place but with greater coordination challenges than in a face-to-face meeting. Therefore, the breadth of the discussion, the transfer of information from the discussion to the report and the coordination style are the three mediators that may affect the outcomes.

Figure 1 summarizes the research model.



**Figure 1. Research Framework**

## 2.1. Hypotheses

The task of solving a case study generally involves two different components, namely: group discussion and report writing. Although a large number of previous

empirical studies have examined computer-supported synchronous groups (e.g. [1], [12]), relatively few (e.g. [14], [21]) have looked at asynchronous groups where the interaction and discussion are delayed in time.

An asynchronous environment frees users from temporal and geographical constraints [19], allowing team members to reflect more about their own contributions and to have broader discussions [9], than groups working in a face-to-face environment with no computer support. These assertions lead to the following hypothesis.

*H1: ALN-supported groups will have broader discussions than will their manual counterparts.*

ALNs allow individuals to have a transcript of their discussions and ease the process of putting together a final report. The asynchronous communication system will improve the group's ability to exchange information [9] and build the report directly from the members' contributions. Groups working without computer support would have to do this transfer of information from the discussion to the reports manually, incurring in a greater loss of information than computer-supported groups. These conjectures lead to the following hypothesis:

*H2: When transferring the contents of their discussion to the final report, face-to-face groups will incur in a greater loss of information than ALN-supported groups.*

The broad nature of the discussions through an ALN system combined with the ability to exchange more information [9] should help groups to produce more complete reports than unsupported groups. A report is considered to be complete if it addresses all the issues included in the teaching note of the case. Thus,

*H3: ALN-supported groups will submit more complete reports than will their manual counterparts.*

Due to the nature of the asynchronous environment in which participants can reflect more about their contributions [9], and because of the ease of editing the transcript of the discussion, asynchronous groups should produce longer reports than manual groups [14]. Therefore,

*H4: ALN-supported groups will produce longer solutions to the case than will their manual counterparts.*

Prior studies comparing asynchronous groups with their manual counterparts (e.g. [14], [21]) find that asynchronous groups tend to produce better solutions and

to report lower satisfaction with the process or the outcome than face-to-face groups.

Non-simultaneous (or asynchronous) groups may be more creative in their answers [14], and reach a deeper level of analysis and higher quality responses [19] than manual teams. But, group members in asynchronous conditions are often frustrated by the low frequency of other members' participation, or lack thereof. This frustration may be more evident in student groups than in real groups with a history of operating under peer pressure.

In an asynchronous environment, it is difficult for the group to decide how to proceed if members do not "show up" on-line [10] or how long to wait for absent members. Studies on asynchronous groups carrying out complex tasks with a deadline (e.g., [5], [21]) have found that the problem of non-participation or delayed participation tends to frustrate many participants, lowering their levels of satisfaction.

The perception of discussion quality in asynchronous computer-mediated discussions suffers because of participation problems, such as absent members [21], "login-lags" among team-members [5], and the pressure to meet the deadlines. Therefore,

*H5: ALN-supported groups will report lower levels of discussion quality than will face-to-face groups.*

The coordination challenges for groups working in an ALN environment are greater than those for groups working through a synchronous decision support system or face-to-face without computer support. Asynchronous teams must decide how to organize the flow of work and deal with temporal gaps in communications.

In absence of special software to track high levels of interdependence, coordination modes requiring low levels of interdependence are preferable in an asynchronous environment, where participants login at their own convenient times, and may not follow a regular pattern of communication. The challenges of working in asynchronous environments along with participation problems should force online groups to adopt a loosely coupled coordination approach, while face-to-face teams can follow tightly coupled approaches. These arguments lead to the following hypothesis:

*H6: ALN-supported groups will tend to follow parallel or pooled coordination approaches, while face-to-face groups will adopt a more tightly coupled mode.*

In sum, there is an inherent trade-off in the use of asynchronous group support systems for the two components of the task (discussion and report writing). On the one hand, group members can reflect longer about their contributions, can participate when they choose to,

can focus on those parts of the task that they like and can exchange more information. On the other hand, there are coordination problems and delayed participation that may frustrate some team members, affecting the group outcomes.

### 3. Methodology

In order to test the hypotheses, this research used a quasi-experimental design comprised of experimental and control groups in a real educational setting. Participants were students enrolled in an upper-level undergraduate core course in Computers and Society at a large technological university.

Experimental groups used an asynchronous text-based computer-mediated communication system. The system features e-mail and computer conferencing, enhanced with software features to support specific academic activities [9]. One of such features is the "question/response activity", which enables each member of a group conference to enter his/her own response to a specific question or problem, before being allowed to see the responses of other members of the group. This promotes independent thinking about individual entries prior to a group discussion and reduces the possibility of free-riding.

The task was the discussion and solution of a case study in computer ethics, which was implemented as one of the assignments in the course. Students were told that their participation was voluntary and if they chose not to participate in the research, an alternative assignment would be made available for them. The case study was furnished with a worksheet of five questions to guide the crafting of the solution. The teaching note of the case is also based on these questions [4].

Randomly created experimental and control groups took part in this study. The a-priori size of the groups was five to six members, but due to "no shows" in face-to-face groups and "no participation" in ALN groups, both conditions ended up with a different number of students and group size ranged from four to six. Twenty-eight students grouped in five teams worked in the control (or face-to-face) condition. Seven teams were assigned to the ALN condition. However, two groups of three students were not included in this analysis due to their small group size. Thus, a total of twenty-two students (organized in five teams) were included in the asynchronous condition.

#### 3.1. Experimental Procedures

Manual groups received the text of the case one week before the date of the group discussion and were advised to prepare individual position statements for the upcoming group meeting. The group composition was not disclosed at this time to avoid meetings before the actual discussion

session. At the group meeting, participants were organized in teams (according to a previous random group assignment). Face-to-face discussion sessions lasted up to two hours and were tape-recorded.

ALN groups also received the case and the instructions for the assignment in advance through the computer conference. Each ALN group was placed in a different conference, which was seeded with the same comments. Members of ALN groups had to use the question/response activity to post their individual position statements in the conference before the starting date of the group discussion. Aside from the deadline for the individual position statements and the group report, no specific coordination instructions were given in the conference.

Experimental groups discussed and solved the case by using the asynchronous system as the only means of communication. Control groups solved the case study by discussing the issues in a face-to-face meeting with no computer support. As a result of the discussion, each group prepared a final report on the case, answering the worksheet questions. Both conditions were aware that this was an open-book exercise and that notes and books could be consulted at any time. Upon completion of the experiment, all participants filled out a questionnaire to rate their perceptions and were debriefed about the experiment a week later.

A series of pilot trials determined the time periods needed by the different conditions to complete the task. Pilot tests were conducted for both conditions with tentative deadlines for asynchronous groups and "no end" time for face-to-face meetings. These trials showed that face-to-face groups needed from one to two hours to discuss the case and produce the final report. Asynchronous groups required one week to ten days to complete the requirements of the task.

To validate the time period decisions suggested by the pilots, we compared our findings to prior studies based on asynchronous and face-to-face groups. We found that some studies have used roughly the same amounts of time. For example, [21] allotted 1.75 hrs to their manual teams and up to two weeks to their asynchronous groups for a murder mystery (asymmetric information) task.

### 4. Data Analysis and Results

Three data sources were analyzed for this study, namely: discussion records, group reports and questionnaire responses. To obtain the discussion records, face-to-face sessions were recorded and transcribed, and online discussions were downloaded from the communication system. The reports were identically formatted.

In order to test the research hypotheses, group sessions and final reports were analyzed based on the comprehensive list of issues included in the teaching note

[4]. This target list was the benchmark to examine both the discussions and the reports.

To parse the discussion sessions, two research assistants, unaware of the experimental conditions, examined each discussion transcript and recorded a "match" for each issue from the list that was mentioned. The level of inter-coder reliability was .91.

Based on the discussion transcripts, the assistants assigned a coordination code to each group (1=parallel, 2=pooled, 3=concurrent, 4=sequential and 5=reactive/reciprocal), according to the classification presented by [23].

The coders also parsed the final reports according to the target list of issues of the teaching note and recorded the matches. The level of agreement among them was .89. In each case, the assistants solved their disagreements by discussing their differences and agreeing on the final mark.

A measure of "efficiency in information transfer" was computed based on the issues that were mentioned in the discussion but did not appear in the corresponding final report. This indicator was calculated by comparing the issues mentioned in the discussion directly to the issues mentioned in the final report. A lost item was an issue mentioned in the discussion but not reflected in the final report. The proportion of lost items would give a measure of the information efficiency transfer from the discussion to the report.

Table 1 summarizes the means and standard deviations of the variables of interest along with the results of the Analysis of Variance.

**Table 1. Summary of Results**

Variables	FtF Means (std)	Asyn. Means (std)	F
Discussion Breadth: Proportion of matches	52 (8.89)	72 (13.95)	7.31*
Report Completeness: Proportion of matches	38.6 (9.71)	61.8 (15.4)	8.12*
Report Length: Number of words	405 (95)	682 (237)	15.65**
Transfer Efficiency: Proportion of items lost	15.2 (7.76)	14.2 (5.45)	0.05
Perception of Discussion Quality: eight item scale	34.70 (4.58)	27.6 (5.79)	28.04**

\*significant at p<.05; \*\* significant at p<.01

Regarding the breadth of the discussion, ALN groups covered on average 72% of the issues of the teaching note, while face-to-face groups mentioned on average about 52% of the items in their verbal discussions.

Statistical results are consistent with the predictions of H1. Asynchronous groups mentioned more issues and had broader discussions than their manual counterparts.

On their final reports, asynchronous groups also mentioned more issues (about 62% on average) than face-to-face groups. The empirical results show that online groups submitted more complete reports than their manual counterparts, supporting H3 at p = .02. A count of the number of words in each final report was used to assess the length. The statistical analysis shows that ALN-supported groups submitted longer reports (682 words on average) than their manual counterparts (average of 405 words). Therefore H4 is supported by the data with a significance level of p = .0002.

These two attributes of the reports (completeness and length) suggest that the coverage of more issues in the final reports of asynchronous groups is more a function of the richness of their discussion than their ability to write more.

#### 4.1. Comparison of discussions with final reports

The most direct way to measure "transfer efficiency" is to subtract the number of issues mentioned in the discussion from the number of issues presented in the final report. A count of zero would indicate a perfect transference of items from the discussion to the report. However, this indicator could be misleading if items discussed do not appear in the report and items not mentioned before show up in the final write-up. In particular, when the number of items discarded equals the number of items added, the direct subtraction is an incorrect indicator of transfer efficiency.

For example, one group had the same number of matches in the discussion and in the final report, giving a count of zero information loss, because number of issues mentioned in discussion was equal to the number of issues presented in the report. However, an item by item inspection of the data revealed that this group had "lost" three items from the discussion to the report, and had "added" three new items to the report. This is a good illustration of how the subtraction indicator may signal a perfect transference when in fact there is a loss of information.

In light of this situation, transfer efficiency was measured by comparing the matches in the discussion one-by-one directly to the matches in the final report. A lost item was an issue mentioned in the discussion but not reflected in the final report. The proportion of lost items would give a measure of information transfer for each group.

It is interesting to note that both conditions show a similar percentage of lost items (about 15%), despite the inherent differences in the process of transferring the contents of the discussion to the final report. Since there

are no significant differences between these percentages, H2 is not supported by the data.

Taken together these results suggest that the asynchronous mode truly generates more useful information in the discussion process. There is a process gain at work, instead of a process loss (lack of transfer efficiency) for manual conditions.

#### 4.2. Perception of Discussion Quality

The perception of discussion quality was measured through an eight-item semantic differential scale anchored at five points, developed by [7]. Table 2 shows the questions used for this measure.

**Table 2. Scale for perception of discussion quality**

1. The overall quality of the discussion was:	
Poor	Good
2. The discussion was*:	
Effective	Ineffective
3. The outcome of the discussion was*:	
Satisfactory	Unsatisfactory
4. The discussion was:	
Incompetently executed	Competently executed
5. The issues explored in the discussion were:	
Trivial	Substantial
6. The content of the discussion was*:	
Carefully developed	Carelessly developed
7. The manner in which the participants examined the issues was:	
Non-constructive	Constructive
8. The group's movement toward reaching a conclusion on the discussion was:	
Insignificant	Significant

\* Items reversed for scoring

The reliability of the scale was .87. Since the scale was deemed reliable, the responses to the items were added up to create a composite score for discussion quality. Manual groups reported significantly better perceptions of discussion quality than ALN groups, which supports H5 at a significant level ( $p=.0001$ ). However, these perceptions are not consistent with the objective results of discussion breadth obtained before, which shows the natural bias people have in favor of face-to-face meetings.

#### 4.3. Coordination Approaches

Groups in each condition adopted a different coordination mode, despite having similar instructions and the exact same case worksheet to prepare the final reports. Face-to-face groups normally began their discussions by trying to answer each of the five questions on the case worksheet in the order in which they were

presented. For each question, face-to-face participants read or referred to their individual statements. All the transcripts revealed that face-to-face groups followed the questions on the case worksheet in a linear fashion. See an illustration of the sequential strategy in Appendix A1.

In order to prepare the final report, every manual group appointed a member in charge of taking notes during the discussion. This person had the responsibility to submit the group report at the end of the session. Sometimes, the rest of the group had to wait until the note-taker could write down the important aspects of the discussion (see excerpts on Appendix A1). In a few cases, the note-taker added extra ideas to the final report. This explains why some issues not mentioned in the discussion appeared in a few group solutions.

ALN groups adopted different coordination approaches. Since they could read the entire statement from the rest of the team after entering their own opinions, they could easily identify their disagreements. They usually began their discussion by trying to solve their differences and only when the deadline was approaching, they paid attention to the worksheet questions. In asynchronous groups, most of the time was consumed in the solution of the disagreements (discrepancy reduction) or discussion of new issues that came up.

During the course of the experiment, asynchronous groups had to decide how and when to proceed if they encountered missing/absent members. The rest of the team identified them when they failed to post their individual position statement by the deadline. Appendix A2 presents an excerpt that shows how a group decided to deal with absent members.

Since the asynchronous communication system used in this study did not allow joint authorship of documents, ALN-supported groups had to decide how to put together the final report. Two options were available to them, either to select a member in charge of compiling the individual contributions into a group report or to split the questions among them and then put together the answers (see excerpts in Appendix A2).

In the asynchronous condition, three groups appointed a representative to compile the individual contributions and develop a group report (pooled coordination), while two groups decided to assign each participant a different part of the final report (parallel coordination). In the pooled coordination mode, the compiler summarized the individual position statements based on the discussion transcripts, and posted drafts of the final reports to get approval from the rest of the team. In one online group, the compiler exercised some discretion and added extra ideas to the final report. But when the drafts were presented for approval, nobody seemed to detect or object to these extra ideas.

In sum, manual and ALN groups adopted different coordination approaches. All manual groups followed a

combination of concurrent and sequential mode to discuss the case and develop the report, while ALN groups followed parallel and pooled approaches.

In order to analyze the coordination style variable, the five levels proposed by [23] were grouped into three categories (low, medium and high) according to the degree of interdependence of each coordination style. Parallel and pooled modes were placed in the low bracket, concurrent and sequential in the middle and reactive/reciprocal in the high end of interdependence.

Table 3 shows how many groups in each condition worked at a particular level of interdependence. A chi-square test was conducted to determine whether the groups in each condition adopted significantly different coordination approaches.

**Table 3. Results of Coordination Style**

	<b>Low</b> (Parallel, Pooled)	<b>Medium</b> (Concurrent, Sequential)	<b>High</b> (Reactive / Reciprocal)
Face-to-Face	–	5	–
Asynchronous	5	–	–
$\chi^2 (2) = 10^{**}$			

\*\* significant at  $p < .01$

The chi-square with two degrees of freedom is significant at  $p < .01$ . This confirms H6, which predicted asynchronous groups would adopt loosely coupled interaction modes with lower levels of interdependence when compared to face-to-face teams.

## 5. Summary and Discussion of Results

Consistent with H1, the breadth of asynchronous discussions is higher than the number of ideas mentioned face-to-face. This may be due to the very nature of asynchronous interaction, which allows one to reflect and come up with new ideas, and discuss more issues than in face-to-face meetings. This result confirms findings of idea generation research, where computer-mediated groups generate more ideas than their manual counterparts [13].

Broader discussions translated into more complete reports for ALN groups, as predicted by H3. Clearly, the discussion of a wider variety of issues had a positive impact on the completeness of the final report. According to H4, the ability to pool more information along with the ease of compiling individual contributions from the written transcripts led to longer reports for online groups.

In both conditions the loss of information from the discussion to the report was minimal and non-significant.

In online groups, this transfer efficiency could be explained through the availability of a written transcript of the discussion that facilitates the development of the final report. Contrary to the expectations for face-to-face groups, the lack of computer support to transcribe the content of the discussion and produce the final report did not increase the loss of information. This loss appears to be a natural process of rejection of ideas during the discussion, rather than a function of the communication medium.

Interestingly, some compilers in both conditions incorporated extra ideas into the final report. Issues that were never mentioned in the discussion appeared in the final document. It seems that the compiler felt confident enough to put some of his/her own ideas into the final report. This phenomenon is also noticed by [15, p. 96], "it appears that the one who holds the pen has some license". Although in ALN-supported groups, the compiler submitted one or several drafts to get approval from the rest of the team, nobody detected or objected to the "extra ideas." This underscores the need for better support for group composition tools in the communication software.

Content analyses of group sessions and reports offered interesting insights into the nature of group coordination. Face-to-face groups covered the questions in the worksheet in a sequential way. In each question, the students made short contributions based on the individual position statements they prepared before the class, or based on their consultation of books and notes "on the spot."

Asynchronous groups adopted more loosely coupled interaction approaches, where they could work in parallel in different sections of the report or just pool their responses to produce the final write-up. Some ALN groups also set their own internal deadlines to deal with the problem of absent members. Overall, these groups showed a more active involvement in the coordination of their workflow and greater focus on discrepancy reduction than their manual counterparts.

The implications of these findings are manifold. First, asynchronous groups experience clear process gains and their discussions are broader than exchanges in unsupported face-to-face meetings. Second, as a result of richer discussions, asynchronous groups are able to submit more complete reports, which are better and longer than the ones submitted by manual groups. Third, the difference in electronic communication support does not seem to affect the efficiency with which groups transfer information from the discussion to the reports. Fourth, in terms of coordination style, groups adopt different approaches depending on the requirements of the task and possibilities of the communication medium.

## 5.1. Limitations

Several limitations of this study warrant mention. First, the lower internal validity of a field experiment [16], where some variables such as the number of students enrolled in each section cannot be controlled because the experiment is taking place in a real setting. In compensation, results from field trials are more generalizable than those in a laboratory experiment because participants solve the task or assignment resulting in a grade or other "real" consequence, and thus a field experiment has higher external validity than a controlled experiment [16].

Another limitation is the small sample size. A total of fifty subjects participated in this research. It would have been desirable to have more participants and more groups in each condition but given the number of students enrolled in the course, the no-shows and the loss of groups, this was not possible. However, there are interesting lessons to be learned from the analyses presented here and the results could lay the foundations for larger-scale studies.

There is also the question of what constitutes an equivalent amount of time in face-to-face and asynchronous meetings. Were both conditions given enough and equivalent time? Since all the groups finished their assignment by the deadline, we conclude that the allotted time was enough. In addition, we tried to establish the equivalence by conducting previous pilot tests and by validating our task times with prior empirical studies of this nature.

It is difficult to estimate how much time participants in asynchronous conditions devoted to the task. One way to overcome this limitation in future studies is to furnish the system with log counters or voluntary sign-up tools to measure the time each subject spends online performing task-related activities.

Finally, since this was an academic exercise and we wanted to limit the possibility of free-riding, students in both conditions were instructed to prepare their individual position statements for the case before the group discussion. In asynchronous groups, the students posted their individual opinions first via the question/response activity. It is not clear if the dynamics in the group discussion would have been different had the participants not prepared their individual positions in advance. This is an area that could be explored in future studies.

## 6. Conclusions

Through content analyses, this study has examined three critical issues to compare asynchronous with face-to-face group interaction, namely: discussion breadth, transfer efficiency and coordination approach. The range of issues mentioned on the group discussion (discussion breadth) could be construed as a measure of group

productivity. The efficiency in transferring information from the discussion to the report could be interpreted as a measure of process loss. The coordination mode adopted by the group could be presented as a response to the constraints imposed by the verbal or electronic medium.

The articulation of these three research variables (discussion breadth, transfer efficiency and coordination style) helps to explain why asynchronous groups obtain superior performance [2] and better subjective learning outcomes [3] than groups working manually in face-to-face meetings.

Content analysis of group discussions and reports in both conditions show that better outcomes of ALN groups are mainly due to the larger number of issues brought up in the discussion (a process gain). Interestingly, groups in both conditions showed about the same efficiency in transferring the contents of their discussion to the final report. In other words, the process loss was insignificant and about the same for groups in both conditions.

The comparative content analysis of group discussions also revealed how asynchronous groups cope with "login-lags" or absent members, and how online groups coordinate their work. One way to improve the current generation of asynchronous communication systems is to include explicit ways to deal with these issues. These findings suggest that a combination of face-to-face and asynchronous meetings could be an ideal approach when there is a need for richer discussions and occasional interpersonal contact or "touch-base" meetings.

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## Appendix A: Discussion Excerpts

### A.1 Face-to-face Groups

The sequential approach as illustrated by the following quotes:

S1: So, let's shoot to the first question... Let me read it...

S2: What is the second question?...

S3: I think that should be enough... let's move on... next question.

Sample of comments to the note-taker:

S1: Did you get that in writing?

S2: What have you written in this question? Could you read it back to us?

### A.2 Asynchronous Groups

The following exchange shows how one online team chose to deal with absent members.

S1: Is there anybody else in our group? So far {list of names} and I are the only people who have responded to this discussion. I think we should wait until Wednesday. If nobody else answers the questions, then I think we should do it ourselves. I don't want to wait too late before we decide what to do because I have work in other classes. I don't want to fall behind, so if they don't answer I think we should do it ourselves.

S2: I agree that we could wait till Weds. to start doing the report. Just like you I don't want to wait until the last minute to do the project.

S3: Hey, I'm here. Sorry I took kind of long to respond to the activity. I had 2 papers and a lab report due this week! Anyway, my response is in and I read over the other responses that were there. So exactly how do you guys want to go about solving these questions together?

S4: Since the final report deadline is approaching, we are moving ahead without you guys.

The following quote summarizes the options available to online teams in order to put together the report.

S1: Guys, do we have to all do a part or the group report or does one person have to do it all? I feel that we should all chip in because it's not fair for all the work to fall on one person, especially when its so close to the end of school. Any ideas? Can we each do a part and then merge them together? Can we even do that? Is it just that one person has to write the report with input from all of us?

Some members were looking for volunteer compilers in their groups, as illustrated below:

S1: After you have finished the first part of this assignment are there any volunteers to submit the final copy? If not lets talk about it so we can get something together.

While others adopted a more executive approach, by appointing a specific member:

S1: {name of a teammate}, I agree that we should put together the final group assignment as soon as possible. After reading your assignment, I think you would be a good coordinator. Please take charge and let everyone in our group know what we should do to contribute.

Other groups were more egalitarian in terms of the distribution of their work:

S1: Folks, why don't we each answer one of the questions and submit it to the conference. Then one of us can collect all the responses into a collective report.