Effects of Asynchronous Learning Networks: Results of a Field Experiment Comparing Groups and Individuals

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Abstract

An Asynchronous Learning Network (ALN) is a Computer-Mediated Communication System designed to support "anytime/anywhere" interaction among students and between students and instructors. A field experiment compared groups and individuals solving an ethical case scenario, with and without an ALN, to determine the separate and joint effects of communication medium and teamwork. Undergraduate students in Computers and Society analyzed the case as an assignment in the course. Dependent variables include quality of the reports, learning as measured by similar cases on the final exam, and subjective perceptions of learning.

The results indicate that working in a group, instead of alone, tends to increase motivation, perception of learning and solution satisfaction. Individuals working online produced higher quality reports on the ethics scenario than individuals working manually, and computer-supported groups produced the longest reports, while individuals working manually produced the shortest reports. Regarding group conditions, manual teams reported significantly higher levels of process satisfaction, perception of process structure and perception of discussion quality than teams supported by an asynchronous communication medium. However, computer-supported groups reported the highest levels of perceived learning. Finally, perception of collaborative learning does not seem to be affected by the use of the medium; both supported and unsupported groups perceived about the same levels of collaborative learning.

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1. Introduction

Asynchronous Learning Networks (ALNs) represent a new paradigm for teaching and learning, with both unique problems of coordination and unique opportunities to support active, collaborative (group or team-based) learning (Harasim et al. 1995). An interesting research opportunity comes from the study of collaborative learning from the asynchronous perspective. Although the advantages of collaborative learning as opposed to didactic teaching have been well promulgated (Harasim, 1990; Slavin, 1987), more research is needed to explore how technology-mediated asynchronous interaction affects the collaborative learning process in itself.

The study of asynchronous groups provides significant opportunities and challenges. One of the most important benefits is the possibility of teaming up groups of people who would have been impossible to assemble in face-to-face or synchronous conditions. But due to the very nature of asynchronous interaction, team members may get anxious or frustrated when they do not get timely feedback from the rest of the group.

Two fundamental research questions were addressed in this project. First, to explore the effects of ALNs in individuals working alone or in groups in three areas: task performance, learning and satisfaction. Second, to investigate how does an ALN affect the collaborative learning process that takes place in group interaction?

2. Theoretical Background

2.1 Task Performance and Satisfaction

The groupware literature contends that task performance is contingent upon contextual factors such as group composition, member characteristics and abilities, task type and technological support; and their interaction. From this literature, it is clear that a group can produce better results than any of its members acting alone (McGrath and Altman, 1966). There are some advantages (or process gains) derived from working in groups that individuals working alone would not achieve. Examples of such gains are: synergy, the ability to consider more information, objective evaluation, cognitive stimulation and member capacity to learn from other members (Nunamaker, et al. 1991). However, comparisons between groups and individuals have not been fully explored. Studies of computer-supported groups have not compared the relative advantages and disadvantages of working in groups vs. working alone with the technology.

Individuals working alone draw from their own knowledge base and sources of information, and do not endure coordination problems in order to accomplish a task. However, individuals working by themselves have to think in isolation, without social support and without group feedback. Depending on the difficulty of the task, these elements may increase anxiety and uncertainty and impair performance. At the individual level, two key factors seem to trigger good performances: the nature of the task and the extent to which the performance will be externally rewarded through economic rewards (e.g. money or prizes), academic rewards (grades) and social rewards (public exposure of individual outcomes) (Shepperd, 1993).

Technological support for group processes can be divided into synchronous (usually decision room systems) and asynchronous systems. Pinsonneault and Kraemer's meta-analysis (1989) concluded that both synchronous systems and asynchronous systems increase a group's depth of analysis, participation, and decision quality, and decrease domination, when compared to manual groups. Synchronous systems in particular increase consensus, but decrease decision satisfaction and process satisfaction. Asynchronous systems tend to increase the total effort put forth by group members, and decrease confidence in the decisions.

Other studies comparing asynchronous groups with their manual counterparts have found that asynchronous groups tend to produce better solutions, but tend to report lower satisfaction with the process or the solution, than unsupported manual groups. In

fact, asynchronous groups may be more creative in their responses (Ocker et al., 1995), and reach a deeper level of analysis and higher quality responses (Rice, 1984) than their manual counterparts. However, group members in asynchronous conditions are often frustrated by the low frequency of other members' participation or even non-participation (Dufner, 1995; Smith and Vanecek, 1988).

The anxiety produced by delays and different participation rates (or "login-lags") may reduce the quality of decision making, because members may go along with an initial suggestion, even if they do not agree with it, in order to accelerate the process and meet a deadline (Harasim, 1990).

2.2 Learning Effects

Learning can take place not only through individual activities but also in group endeavors. At the individual level, learning involves processing inputs to develop, test, and refine mental models in long-term memory (Shuell, 1986). Thus, learning is a process of constructing, extending and refining mental models, and using them in problem-solving situations (Alavi, 1994). But learning can also emerge from the interaction of individuals with other individuals (Slavin, 1990), through discussion and information sharing during a problem solving process (Leidner and Jarvenpaa, 1995).

One example of a very effective problem-solving activity is the solution of case scenarios. In general, "the goal of the case is to enable students to process instructional inputs and assimilate the course material. Such cases can be analyzed individually or in the context of a group" (Leidner and Fuller, 1996: 294). If case discussions take place in a group setting, higher order cognitive skills are developed (Hiltz, 1994). The contribution of different understandings or the exposure to alternative points of view can enhance learning. Thus, the discussion and solution of case scenarios in groups may accelerate the creation or refinement of improved mental models and augment learning.

Collaboration and teamwork can support the development of advanced mental models for a number of reasons. First, there is an opportunity for evaluation and feedback in which group members can monitor individual thinking and provide feedback for clarification and change (Dillenbourg and Schneider, 1994). Second, the exposure to alternative points of view can challenge understanding and motivate learning (Glasser and Bassok, 1989). Third, a group structure provides social support and encouragement for individual efforts (Webb, 1982; Alavi, 1994).

Despite these mechanisms that seem to promote effective learning in a collaborative environment, there are also potential losses such as free-riding and social loafing, status differential effects and diffusion of responsibility. They may hinder some of the potential advantages of learning in groups (Latané, et al. 1979; Salomon and Globerson, 1989).

Groupware technology can support collaborative learning activities by providing an environment in which group interaction is more effective and efficient. An electronic communication medium to support group processes can increase group process gains, such as synergy, pooling of more information, objective evaluation, cognitive stimulation and learning; and decrease group process losses, such as fragmentation, blocking, domination, evaluation apprehension and information overload (Nunamaker, et al. 1991).

Asynchronous Learning Networks, in particular, can facilitate self-pacing and self-directed learning and increase the time available to read or reread a message and formulate a comment. This can improve in-depth reflection and development of a topic (Harasim, 1990).

3. Review of Previous Empirical Studies

Previous studies in Computer-Mediated Collaborative Learning can be organized in terms of the framework proposed by Johansen (1992). According to this framework, group interaction can occur at the same time (synchronous) or at different times (asynchronous); and group members can be in the same place (proximate) or in different places (dispersed).

3.1 Same Time/Same Place Studies

In recent years, a number of empirical studies comparing learning outcomes in computer-supported synchronous groups versus manual groups have been carried out (e.g. Alavi, 1994; Leidner and Fuller, 1996). The distinctive feature of these studies is the use of synchronous Group Support Systems (or decision rooms) to support group discussion and solution of case studies.

Alavi (1994) compared computer-supported vs. unsupported groups of MBA students solving case studies in an introductory Management Information Systems (MIS) course. The main hypothesis was that the system enhances the effectiveness of collaborative learning (defined in terms of self-reported learning and evaluation of classroom experience) by increasing group process gains and decreasing group process losses (Alavi, 1994: 163). Results supported the research hypothesis, indicating that students' reactions to the Computer-Mediated Collaborative Learning process were more positive than those for the manual collaborative learning process. Computer-supported groups expressed higher levels of perceived skill development, self-reported learning and evaluation of classroom experience in comparison with non-supported groups. Although there were no significant differences in midterm scores, final test grades for students in computer-supported groups were significantly higher than those of the students in non-supported groups (Alavi, 1994).

Leidner and Fuller (1996) examined whether a technology-supported collaborative learning environment involving case analyses is superior to individual learning involving individual case analyses. The goal of both methods was to increase student interest in the course, student understanding of the material and enhance student performance. The study found that students who discussed the cases in groups were more interested in the material and perceived themselves to learn more than students working alone. However, students who worked independently outperformed students that discussed the cases in groups before solving them individually (Leidner and Fuller, 1996).

There are interesting similarities among these two studies. They all ran for at least one semester and were focused on MIS introductory courses, using synchronous GSS to discuss several case scenarios. Moreover, the findings across studies seem to be favorable to the use of GSS tools to support case discussions.

3.2 Same Time/Different Place Studies

Alavi, Wheeler and Valacich (1995) conducted a longitudinal field study (three work sessions) to investigate collaborative learning among non-proximate team members using Desktop Video Conferencing, and compared the efficacy of this environment to that of a synchronous/proximate environment and a traditional unsupported face-to-face environment. The study found that the three environments are equally effective in terms of student knowledge acquisition and satisfaction with their learning process and outcomes. Distant teams showed higher critical skills and more commitment to their groups than the other conditions.

3.3 Different Time/Different Place Studies

Asynchronous Learning Networks can be placed in the asynchronous/dispersed category of Johansen's (1992) framework. In this area, one of the most important studies is the use of Virtual Classroom™ (VC). Over the last decade, a variety of courses has been delivered with this ALN system, including 26 courses in Computer and Information Science taken by over 1000 students. This study found no consistent significant differences between traditional (non-supported) courses and VC-supported classes in mastery of the material (actual learning) as measured by grades. Subjectively, however, most students reported that VC is overall a better way of learning than traditional classes (Hiltz, 1994; Hiltz and Wellman, 1997).

Cross-sectional data obtained from this study does not allow us to examine the effectiveness of collaborative learning as a pedagogical technique in asynchronous/dispersed teams.

4. Hypotheses

It is necessary to systematically investigate the effectiveness of collaborative learning in asynchronous/dispersed environments, using an ALN. The existing literature points to the need to separate the effects of working in groups (teamwork) and of using an ALN in three areas: task performance, satisfaction and learning. Based on the review, the following hypotheses were formulated:

4.1 Task Performance

If a Computer-Mediated Communication System can showcase individual work, then individuals working with the technology should outperform individuals working manually, due to the potential exposure of their work to peers and the potential for social rewards (Shepperd, 1993).

H1a: Individuals working with ALN technology will produce higher quality solutions than will individuals working without computer support.

In general, groups are better than individuals at making decisions (Hill, 1982). Partly, this is because groups are more creative at generating options and probing their advantages and disadvantages than are single individuals (Turoff and Hiltz, 1982). Moreover, according to the moral reasoning literature, ethical discussions among group

members are superior to an individual's consideration of a dilemma (Peek, et al.; 1994). Therefore, one would expect that group solutions will be better than individual solutions to ethical case scenarios. In line with these ideas, we hypothesize:

H1b: Groups will produce higher quality solutions to ethical dilemmas than will individuals.

Due to the nature of the asynchronous environment in which participants can reflect longer about their contributions (Hiltz, 1994), computer-supported conditions will tend to produce higher quality solutions than their manual counterparts (Ocker, 1995). Increased opportunity for member input may enhance the quality of decision making (Rice, 1984). Therefore,

H1c: Participants in computer-supported conditions will produce higher quality solutions to the ethical scenarios than will their manual counterparts.

Another element that could be used to judge task performance is the length of the reports. It is expected that group reports will be longer than individual reports, because groups are able to pool more ideas and information from different sources in order to solve the case, in a given amount of time. The use of the communication system will also allow groups and individuals to submit longer responses than their manual counterparts, because of the ease of editing and improving the text using a computer editor as opposed to pencil and paper.

For unsupported face-to-face groups, two opposite effects will be present. On the one hand, due to the combination of contributions from different team members, longer responses will be possible. But, on the other hand, since the groups will not have access to the technology to submit their responses and retrieve others', there may be a tendency to summarize the discussions and to shorten the reports. Therefore,

H1d: Computer-Mediated groups will produce the longest reports, while individuals working manually will submit the shortest reports.

4.2 Learning Outcomes

This study is concerned with two different measures of learning: self-reported or perceptual learning, and observed learning as reflected in exam performance.

4.2.1 Self-Reported Learning

Due to the advantages of teamwork, it is expected that participants working in groups will perceive that they have learned more than participants working alone. Thus,

H2a: Group participants will perceive higher levels of self-reported learning than will individuals working alone.

Moreover, the combination of asynchronous work, i.e. more time to process a comment and think about personal contributions, linked to the availability of a written transcript of the interaction, can augment learning. Hence,

H2b: Computer-supported participants will perceive higher levels of learning than will non-supported participants.

Due to the advantages of working in groups (exposure to different viewpoints and understandings) and the availability of an asynchronous system to support group communication, a positive interaction effect between teamwork and computer-support is expected. Therefore,

H2c: Computer-supported groups will perceive the highest levels of self-reported learning.

The perception of collaborative learning should not differ between supported and non-supported groups. Traditionally, face-to-face has been the method for group discussion, but computer-mediated communication systems are well suited for collaborative learning activities (Hiltz, 1994). Hence,

H2d: Computer-Mediated and face-to-face groups will report about the same levels of perception of collaborative learning.

4.2.2 Actual Learning

Collaborative or group learning involves the three attributes of effective learning: active construction of knowledge, cooperation or teamwork, and learning by problem solving (Alavi, 1994). Therefore, it is expected that, as measured by final exam scores:

H2e: Group participants will learn more than will individual participants.

The on-line exposure to alternative points of view and different responses will enhance learning (Glasser and Bassok, 1989) in computer-supported individuals when compared to individuals working without computer support. Therefore,

H2f: Participants working on-line will learn more than will participants working manually.

As in the case of self-reported learning, the availability of a written transcript of the interaction, linked to the flexibility to participate by choosing the most convenient time and place, can augment learning (Harasim, 1990; Hiltz, 1994). Hence,

H2g: Participants in computer-supported groups will learn more than will participants in any other condition.

4.3 Motivation and Satisfaction

According to Harasim (1990) and Webb (1982), when working with peers instead of alone, anxiety and uncertainty are reduced as learners find their ways through complex or new tasks. These effects tend to increase motivation and satisfaction with the process and outcomes. Therefore,

H3a: Group members will report higher levels of motivation than will individuals.

H3b: Solution satisfaction will be greater for those participants working in groups than for those working alone.

The use of an ALN may tend to reduce solution satisfaction. Harasim (1990) points out that when groups are using time-independent (asynchronous) communication, members may go along with an initial solution, even if they don't agree with it, in order

to accelerate the process and meet the deadline. This tendency can result in lower levels of solution satisfaction in Computer-Mediated groups. Therefore,

H3c: Computer-mediated groups will be less satisfied with the solution than face-to-face groups.

When group interaction is mediated by an ALN, it is expected that the satisfaction with the process will decrease due to participation problems: absent members (Smith and Vanececk, 1988) and "login-lags" among team-members (Dufner, et al., 1994). Hence,

H3d: Face-to-face groups will report higher levels of process satisfaction than will computer-supported groups.

The use of an asynchronous communication system may deteriorate the perception of process structure, discussion quality and process gains in computer-supported groups.

H3e: Computer-supported groups will report lower perception of process structure than will their face-to-face counterparts.

H3f: Computer-supported groups will report lower discussion quality than will face-to-face groups.

H3g: Computer-supported groups will report lower perception of process gains than will face-to-face groups.

5. Research Design and Methodology

The experimental design was a 2x2 factorial (Figure 1), crossing two modes of communication (manual-offline vs. asynchronous computer conference) and two types of teamwork (individuals working alone vs. individuals working in groups). In the Individual/Manual condition (IM), students solved the case individually, in an in-class exercise like an open-book quiz. In the Individual/Online condition (IO), students submitted their individual responses in a computer conference by using the Question-Response activity software that is part of Virtual Classroom™. This feature allows students to submit their individual responses without seeing what anybody else has written, but after their solutions are posted, they can read the answers of others. In the Group/Manual condition (GM), team members solved the case by interacting face-to-face. In the allotted time (two hours), they discussed the scenario and wrote the final report. In the Group/Online condition (GO), team members interacted asynchronously for a week using the computer conference as the only means of communication to discuss and solve the case. The time periods needed by the groups to complete their reports were arrived at through a series of pilot studies.

Figure 1: Experimental Design

Teamwork	*Computer Support* Manual	Online
Individuals	IM	IO
Groups	GM	GO

5.1 Subjects

This experiment was conducted in an actual field setting. The participants were 136 NJIT undergraduate students in an upper-level core course for computer science and information systems majors ("Computers and Society"). Since this course is traditionally offered in two modes --face-to-face and distance --, students in face-to-face sections could be assigned to any condition, while those in distance sections could be assigned to on-line conditions only.

5.2 Technology

An ALN system called Virtual Classroom™ developed at the New Jersey Institute of Technology was used in this field experiment. Virtual Classroom (VC) is a basic Computer-Mediated Communication System enhanced with software features to support specific academic activities (Hiltz, 1994).

5.3 Task

The task was the solution of an ethical case scenario ("Jane's case" in Anderson, et al. 1993). This kind of task accomplishes two objectives at the same time: it encourages group discussion and allows the practice of ethical analysis. A case worksheet was added to the case scenario to standardize the solution reports and to introduce questions with correct answers, whose responses could be objectively graded.

Since the task was implemented as a required assignment, it was possible to obtain a measure of long-term learning (recall and application of concepts) by including two similar ethical scenarios in the final exam for the course.

5.4 Research Instruments

The data collected in this field experiment comes from:

1. Three different questionnaires completed by the participants: Pre-test questionnaire (to collect demographic data); Task Survey (to gather individual perceptions about the task of solving ethical case scenarios); Post-Test Questionnaire (to collect subjective data about the process, the outcome and the communication system used).
2. Evaluation of the final reports by three expert judges unaware of experimental conditions.

5.5 Debriefing of the subjects

After having completed the experiment and the post-test questionnaire, students were debriefed about experimental methods, research design, and hypotheses. Since this experiment was implemented in the context of an actual college course, in the debriefing the students were presented with a model solution to the case.

6. Results

The sample was composed of 136 students, distributed across conditions as follows: 44 in Individual/Manual, 42 in Individual/Online, 28 in Groups/Manual and 22 in Groups/Online. Due to scheduling constraints and the loss of groups in both conditions because of "no-shows", fewer participants completed the experiment in group conditions, but each of these conditions ended up with five teams of 4 to 6 students.

Many of the hypotheses for this experiment are based on composite variables or scales comprised of different items (questions). Before testing hypotheses, each of these scales was validated to assess their level of reliability. A scale was considered reliable only if a Cronbach Alpha Coefficient of .7 or greater was found. In this case, the scores of the items used to create the scale were added up and analyzed for statistical significance to test the corresponding hypothesis.

Because this was a field experiment with many sources of uncontrolled variance, the minimum level of significance for assessing the results as worthy of note was .10. However, a minimum of .05 is required to refer to the results as "statistically significant".

6.1 Task Performance

Hypotheses regarding task performance were tested based on the overall grade reported by the judges. Each judge's score (grade between 0 and 100) was added up to produce a combined measure of task performance for each report. This combined score can vary between 0 and 300.

H1a predicted that individuals working with the system would outperform participants working alone and manually. Results presented in Table 1 show that individuals working online produced significantly higher quality reports ($p < .05$) than individuals working manually, therefore supporting H1a.

Table 1: Means and ANOVA Results for Individual Performance

	Mean IM	Mean IO	F Value	p
Report Grade	157.66	179.67	4.56	.04**

** = Significant at $p < .05$

It was expected that groups would outperform individuals in the quality of the final report (H1b). Analysis of Variance (Table 2) based on the combined score given by the judges showed no significant differences among the four conditions. The results are in the expected direction (group reports > individual reports and online reports > manual reports) but not strong enough to support hypotheses H1b and H1c at a significant level.

Table 2: Means and ANOVA Results for Task Performance

Means by Condition[1]

	Manual	Online	
Individuals	157.66	179.67	168.66
Groups	175.00	178.00	176.50
	166.33	178.83	

Anova Results

Model (TW OL TW*OL)	F = 1.58	p = .20
TW (Teamwork Effect)	F = 0.73	p = .39
OL (Online Effect)	F = 1.86	p = .18
Interaction (TW*OL)	F = 1.07	p = .30

1 Task Performance: min = 0; max = 300

The number of words in each report was computed using the Word Count function of Microsoft Word for Windows™ (V. 6.0). This word count was used to perform an Analysis of Variance on the length of the solutions submitted by groups and individual participants (Table 3).

Table 3: Means and ANOVA Results for Length of the Reports

Means by Condition

	Manual	Online	
Individuals	384.00	473.52	428.76
Groups	405.07	682.09	543.58
	394.54	577.81	

Anova Results

Model (TW OL TW*OL)	F = 8.21	p = .0003	***
Teamwork Effect	F = 5.74	p = .02	**
Online Effect	F = 15.65	p = .0002	***
Interaction Effect	F = 3.67	p = .05	**

** = Significant at $p < .05$; *** = Significant at $p < .01$

The average length of reports produced by computer supported groups was 682.09 words, almost twice the length of individual manual reports whose average number of words was 384. The final reports are significantly larger for group conditions (p =.02) and for online conditions (p =.0002). There is also a significant (p=.05) interaction effect between teamwork and technology. These results support H1d.

6.1 Learning Results

Perception of learning (or self-reported learning) was measured in the post-test questionnaire (Cronbach's Alpha = .92). Means and Analysis of Variance results are shown in Table 4.

Table 4: Means and ANOVA Results for Self-Reported Learning

Means by Condition[1]	Manual	Online	
Individuals	30.47	26.81	28.64
Groups	30.15	31.38	30.77
	30.31	29.10	
Anova Results			
Model	F = 2.07	p = .08	*
Teamwork Effect	F = 3.22	p = .07	*
Online Effect	F = 1.04	p = .31	
Interaction Effect	F = 4.23	p = .04	**

1 Self-Reported Learning: min = 5; max = 40;
*= p<.1; **=significant at p<.05

Groups reported marginally higher perception of learning, than participants in individual conditions, according to the prediction of H2a. However, there was no significant difference between supported and unsupported conditions (online effect p>.1). Thus, H2b is not supported by the data. There was a significant interaction effect between teamwork and technology in self-reported learning. Groups/Online reported slightly better perceptions of learning than the rest of the conditions thus supporting H2c, and Individuals/Online reported the worst perception of learning.

The perception of collaborative learning was measured in the post-test questionnaire for group conditions only (Cronbach's Alpha = .90). Results of the analysis of variance were consistent with H2d. The perception of collaborative learning was about the same between supported and unsupported groups (Table 5).

Actual or long-term learning was measured by the grades that participants obtained in the ethics section of the final exam. Statistical analysis of the grades (not shown here), found no significant differences among the raw scores in each condition (Teamwork p=.34; Online p=.57; Interaction Effect p =.61). However, Individuals/Online were once again the lowest scoring condition. Therefore, hypotheses 2e, 2f and 2g were not supported by the data. Overall, participants seemed to have about the same levels of actual learning, regardless of the condition in which they solved the case.

Table 5: Means and ANOVA for Collaborative Learning

	GM	GO	F Value	p
Collaborative Learning Perception[1]	26.33	27.08	.22	.65

1 Collaborative Learning: min = 5; max = 35

6.3 Satisfaction Results

Motivation was measured in the post-test questionnaire (Cronbach's Alpha = .81). According to the results (Table 6), groups reported marginally higher levels of motivation than individual participants, according to the prediction of H3a.

Table 6: Means and ANOVA Results for Motivation

Means by Condition[1]	Manual	Online	
Individuals	19.02	16.94	17.98
Groups	19.07	19.69	19.28
	19.04	18.31	
Anova Results			
Model	F = 1.97	p = .12	
Teamwork Effect	F = 3.34	p = .07	*
Online Effect	F = 0.91	p= .34	
Interaction Effect	F = 3.10	p = .08	*

1 Motivation: min = 5; max = 25
* = p < .1

Solution Satisfaction was also measured in the post-test questionnaire (Cronbach's Alpha = .73). In this case, groups also reported marginally higher levels of solution satisfaction than individual participants, according to H3b (Table 7). It was hypothesized that Computer-Mediated groups would be less satisfied with their solution than manual groups, but this was not the case. In fact, solution satisfaction levels were slightly higher for Groups/Online than for Groups/Manual.

Table 7: Means and ANOVA Results for Solution Satisfaction

Means by Condition[2]	Manual	Online	
Individuals	15.33	14.95	15.14
Groups	15.96	16.31	16.14
	15.64	15.63	
Anova Results			
Model	F = 1.33	p = .26	
Teamwork Effect	F = 3.58	p = .06	*
Online Effect	F = 0.00	p = .97	
Interaction Effect	F = 0.47	p = .50	

2 Solution Satisfaction: min = 4; max = 20
*= p<.1

The different dimensions of process perception measured in this research were: (1)Process satisfaction, (2) Perceived process structure, (3) Perception of discussion quality, and (4) Perceived process gains and losses. In all these measures, unsupported groups reported significantly better perceptions of the process than computer-supported groups (Table 8).

Table 8: Means and ANOVA Results for Satisfaction with the Process

	Min/Max	Mean GM	Mean GO	F Value	p
Process Satisfaction	5/25	22.57	17.18	30.78	.0001***
Perception of Process Structure	3/15	12.46	10.08	11.35	.002***
Perception of Discussion Quality	8/40	34.70	27.64	28.04	.0001***
Perception of Process Gains	7/35	30.50	24.59	27.52	.0001***

***=significant at p<.01

7. Discussion of Results

7.1 Task Performance

According to the combined score produced by the judges, the quality of the reports submitted by computer-supported individuals was significantly higher ($p < .05$) than the quality of the reports produced by their manual counterparts. It could be argued that supported individuals had more time to think about the case before submitting the response. However, both conditions received the text of the case and the questions one week before the experiment began and had equal time to prepare the solution in advance. The only difference between conditions was how the response was submitted. Individuals/Online entered their response in the computer conference and Individual/Manual solved the case in class. Both conditions were allowed to consult their books and notes.

In length of the reports, as expected, Groups/Online produced the longest reports because of the interaction of two factors, group input (teamwork) and online work (availability of a written transcript of the discussion). In contrast, Individuals/Manual produced the shortest reports due to the absence of both factors.

7.2 Learning Results

Actual learning, as measured by the grades in the ethics section of the final exam, was about the same for all conditions. Further statistical analyses, conducted using the Grade Point Average (GPA) as a covariate, revealed that this was a better explanatory variable than condition alone. But perhaps the most important element that could have helped to equalize the experimental conditions was the availability of the model solution to the case in the debriefing materials, which could be used by participants in all conditions to prepare for the final exam.

Group participants reported significantly higher perception of learning than subjects in individual conditions. There was also a significant interaction effect between teamwork and technology. Computer-supported groups reported slightly better perception of learning than the rest of the conditions, and Individuals/Online reported the worst perception of learning. The availability of the classmates' responses after entering their own report, could have adversely affected the perception of learning in computer-supported individuals. In fact, when confronted with other people's responses some individuals may have felt that their work was inadequate or incomplete, and this feeling may have diminished the perception of learning.

7.3 Satisfaction Results

In terms of solution satisfaction, teamwork was the only factor that seemed to have affected it. In fact, group participants reported higher levels of satisfaction with their solution than individual participants, consistent with the hypothesis. The literature (Harasim, 1990; Webb, 1982) supports this finding arguing that working with peers instead of alone, tends to reduce uncertainty and anxiety and increase satisfaction with the outcome of a group endeavor.

Lastly, consistent with the hypotheses, manual groups reported significantly higher levels of process satisfaction, perception of discussion quality and process gains, than did computer-mediated groups. Dufner et al. (1995) explains this finding as one of the negative aspects of asynchronous computer-mediated communication systems. The lack of continuity in computer-mediated group discussion, or "login lag", tends to create confusion and dissatisfaction among team members. They are often frustrated if they can not complete the assignment due to the lack of participation of some team members.

Moreover, the lack of tools for joint authorship of documents through the computer system contributed to make work more complex for computer-mediated groups. They had to discuss not only the case, but also about how to coordinate and write the final report. For these reasons, computer supported groups reported significantly lower perception of process structure and lower discussion quality than manual groups.

In summary, this study has shown that working in groups, instead of alone, tends to increase motivation, perception of learning and solution satisfaction. For participants working alone, those who used the ALN system produced higher quality reports than those who worked manually. However, individuals working online reported the lowest level of subjective learning. Regarding group conditions, manual teams reported significantly higher levels of process satisfaction, perception of process structure and perception of discussion quality than did computer-supported teams. Both group conditions reported about the same levels of perception of collaborative learning. Finally, computer-supported groups produced the longest reports while individuals working manually produced the shortest reports.

Table 9 summarizes the results of the test of hypotheses.

Table 9: Summary of the Test of Hypotheses

H#	Hypotheses	Result
H1a	*Individuals working with ALN technology will produce higher quality solutions than will individuals working without computer support.*	S**
H1b	*Groups will produce higher quality solutions to ethical dilemmas than will individuals.*	NS
H1c	*Participants in computer-supported conditions will produce higher quality solutions to the ethical scenarios than will their manual counterparts.*	NS
H1d	*Computer-Mediated groups will produce the longest reports, while individuals working manually will submit the shortest reports.*	S***
H2a	*Group participants will perceive higher levels of self-reported learning than will individuals working alone*	NS*
H2b	*Computer-supported participants will perceive higher levels of learning than will non-supported participants*	NS
H2c	*Computer-supported groups will perceive the highest levels of self-reported learning*	S**
H2d	*Computer-Mediated and face-to-face groups will report about the same levels of perception of collaborative learning.*	S
H2e	*Group participants will learn more than will individual participants*	NS
H2f	*Participants working online will learn more than participants working manually.*	NS
H2g	*Participants in computer-supported groups will learn more than will participants in any other condition.*	NS
H3a	*Group members will report higher levels of motivation than will individuals.*	NS*
H3b	*Solution satisfaction will be greater for those participants working in groups than for those working alone.*	NS*
H3c	*Computer-mediated groups will be less satisfied with the solution than face-to-face groups.*	NS
H3d	*Face-to-face groups will report higher levels of process satisfaction than will computer-supported groups.*	S***
H3e	*Computer-supported groups will report lower perception of process structure than will their face-to-face counterparts.*	S***
H3f	*Computer-supported groups will report lower discussion quality than will face-to-face groups.*	S***
H3g	*Computer-supported groups will report lower perception of process gains than will face-to-face groups.*	S***

S = Supported; NS = Not Supported; * = $p < .1$; ** = $p < .05$; *** = $p < .01$

8. Implications

The implications of these findings are manifold. First, the use of an ALN enhances individual performance, due perhaps to the potential visibility that the system can provide to each response, combined with deeper reflection in asynchronous work. The second implication is that the combination of work in groups with use of the system results in longer reports but not significantly higher quality responses. Moreover, groups working asynchronously through the system reported less satisfaction with their solution, and lower perception of process structure and discussion quality than their manual counterparts.

Individuals who used the ALN system outperformed their manual counterparts, but reported the lowest perception of learning among all conditions. Regarding group conditions, those teams who worked through an ALN reported about the same perception of collaborative learning than manual teams. Hence, for collaborative activities, Asynchronous Learning Networks are perceived to be as effective as synchronous learning in traditional classrooms.

9. Limitations of the Study

The use of a field experiment to conduct this study is the source of its strengths and limitations. An experiment conducted in a real setting (a field experiment) has great potential for the generalizability of results, but can be affected by the many factors that can not be controlled for in the real world (Hiltz, Johnson and Turoff, 1991). In this field experiment, some of the internal validity was lost because experimenters have no control over what students are enrolled in which sections (traditional or distance). This loss is compensated for by having better potential for the generalization of the results.

There was a limitation preventing a truly random assignment of subjects to conditions. Students in distance sections of the course could only be assigned to online conditions, while students in traditional (on-campus) sections could be assigned to any condition. As a result of this, most of the participants who ended up in online conditions came from distance sections of the course. Analyses of variance with pre-test data showed that students in distance sections tend to be older, and have much more work experience than students enrolled in on-campus sections. These differences are also present between manual and online conditions in this study.

Since this research was conducted with actual course materials and students, there was a clear reciprocal obligation: instructors should teach and students should learn. On the one hand, the duty to learn was very helpful for the purpose of this research because participants would have a real stake in learning the computer ethics material. Sometimes, they would make an extra effort to study the topic, regardless of the condition in which they solved the case. This additional effort could have helped to level out learning effectiveness measures among conditions. On the other hand, the responsibility to teach computer ethics could have also affected the outcomes of this field experiment. In the debriefing conference, a model solution to the case was included. Therefore, all participants could learn from one example of a very good solution to the case scenario before taking the final exam. Thus, the teaching-learning commitment could have affected the long term learning measures.

10. Conclusions

Online conditions tend to outperform manual conditions due to the combination of asynchronous work, which allows longer reflection about the contributions, and the use of the communication system itself, which facilitates the submission of longer responses.

Regarding group conditions, the study found that manual teams reported significantly higher levels of process satisfaction, process structure and perception of discussion quality than teams supported by an ALN. This highlights one of the main drawbacks of asynchronous interaction, which tends to frustrate active members when they

experience "login-lags" or inactive team members. At the same time, the coordination demands placed on asynchronous groups are higher because they can interact "anytime", but they still must meet the deadline.

However, the perception of collaborative learning is not affected by the use of the medium; both supported and unsupported groups perceived about the same levels of collaborative learning. It seems that an ALN is equally suited for collaborative learning activities as traditional synchronous methods. Therefore, in terms of learning perception, asynchronous and collaborative activities can be as successful as their manual counterparts.

This research has advanced the understanding of the effects of ALNs on learning, performance and satisfaction. It has also highlighted the trade-off of asynchronous work. On the positive side, asynchronous interaction allows participants to produce longer responses; but at the expense of lower process satisfaction. More research is needed to examine in detail the effects of individual, group and media factors in learning, performance and satisfaction, especially with the increasing use of the Internet in educational environments.

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