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Abstract:

Tutored Video Instruction (TVI) is a collaborative learning methodology in which a small group of students studies a videotape of a lecture. We constructed a fully virtual version of TVI called Distributed Tutored Video Instruction (DTVI), in which each student has a networked computer with audio microphone-headset and video camera to support communication within the group. In this report, we compare survey questionnaires, observations of student interactions, and grade outcomes for students in the face-to-face TVI condition with those of students in the DTVI condition. Our analysis also includes comparisons with students in the original lecture. This two and a half year study involved approximately 700 students at two universities.

Despite finding a few statistically significant process differences between TVI and DTVI, the interactions were for the most part quite similar. Course grade outcomes for TVI and DTVI were indistinguishable, and these collaborative conditions proved better than lecture. We conclude that this kind of highly interactive virtual collaboration can be an effective way to learn.

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Table Of Contents

Preface

by William R. Sutherland, Director Emeritus, Sun Labs

This report is the culmination of a multi-year joint effort to examine the value of a particular style of distance learning methodology and technology. The work was sponsored by Sun Labs and has involved SERA Learning Technologies together with students and faculty at California Polytechnic University and Chico State University.

The genesis of the project was a 1995 discussion with Professor Jim Gibbons former Dean of Engineering at Stanford University. Jim has for many years been a proponent of Tutored Video Instruction (TVI), a technique he developed in the 1970s to deliver Stanford engineering classes to off-campus industrial students [Gibbons, Kincheloe, & Down, (1977)]. The TVI methodology has been proven since then in a wide variety of settings to be an effective, inexpensive way to teach all kinds of subject matter.

With the advent of high-performance digital networks and Sun's continuing interest in understanding how networks can be used to provide customer value, Jim and I felt it appropriate to determine whether TVI could be used as a basis for effective network-based instruction. TVI uses a simple videotape of a lecture, viewed by a small group of co-located students, as a guide for their discussion of the subject matter. A tutor-facilitator leads the small group discussion. Twenty-five years of experience shows that off-campus TVI students do noticeably better than their counterparts who attend conventional campus classes. Could the same outstanding results be obtained with a "distributed video conference" of the students and facilitator, augmented with a stoppable video of the lecture tape? We have call this extension to TVI methodology *Distributed Tutored Video Instruction (DTVI)*, and, for clarity, coin the associated term *Co-located Tutored Video Instruction (CTVI)* for the original concept.

The finding here that DTVI is effective promises some significant benefits, particularly as higher bandwidth networks become more pervasive and cheaper.

First, compared to other forms of computer-based instruction that deliver "instructional content" to a single student in front of a screen, the "authoring task" for both CTVI and DTVI is simple: videotape an existing (even boring) lecture. There is no "multi-media" software extravaganza required to create interesting and visual course content to retain the interest and involvement of a solo student. The CTVI and DTVI methodologies depend on the dynamic interaction of the participants for the involvement and attention of the students rather than on the intrinsic interest and polish of the course material. A tape to teach even a small number of students is an affordable undertaking.

Second, students in a DTVI session need not travel to a common site. For industrial applications, I have always liked the possibility of comparing the economics of incremental digital infrastructure required to support DTVI with expenses of co-located classes, including transportation, travel time, and lodging. I believe that at a

significant scale, DTVI will offer real economic benefit in the near future as network costs decline and performance improves.

This report presents the results of a study of over 700 university students who took several different subject matter courses in the three forms of a) conventional classroom; b) face-to-face TVI; and c) networked DTVI, all three with identical lecture content. These preliminary results are indeed promising, although there is lots of room for further research into the numerous unanswered questions. I hope the reader finds the information included here interesting and provocative.

This work was championed by Professor Gibbons and myself, and we at Sun Labs owe Jim a debt of gratitude for his participation and wisdom. The Sun Labs project was led by Randy Smith under the direction of John Dutra. Rob Pannoni of SERA Learning Technologies with Mike Sipusic conducted the study under contract to Sun Labs. We also thank David Ragossa of Stanford's Department of Statistic for his many hours of guidance with statistics. Day-to-day on-site management for a project of this scale is essential: our deep gratitude to Anna Seu and Professor Barry Floyd at Cal Poly, and to Professor Aaron Bor at CSU Chico. Finally, we acknowledge with thanks the contributions of the faculty and student participants at Cal Poly and Chico State who were willing to serve as experimental subjects for this study. Without them, there would be no possibility of meaningful comparison of the three different teaching techniques.

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Palo Alto, California

Part 1: Background

General Description of the Experiment, Theoretical Framework, and Research Methods

Introduction

One-by-one, the technical and cost barriers to high-bandwidth networking are falling. The increasing availability of bandwidth inspires visions of a "Brave New World" where people can work collaboratively without being held hostage to physical proximity. But lost in the frenetic rush toward virtualization is the possibility that there will be an additional cost to the substitution of virtual communication for face-to-face communication. While networks have proven quite adept as a medium for asynchronous and broadcast forms of communication, highly interactive, real-time, multi-way communication has proven more problematic [Sellen (1992)].

Potential problems with technology-mediated communication are particularly significant in the domain of distance learning. Because of the obvious savings in time and travel costs, distance learning is likely to be among the first large-scale uses of high-bandwidth networking technology. The simplest way to apply this technology to distance learning is to recreate the familiar classroom lecture environment. In fact, the broadcast of standard lecture courses has become nearly synonymous with the term "distance learning". However, there is an overwhelming body of educational research showing that instructional methods that foster interpersonal discourse and the social construction of knowledge are more effective than methods that rely on the broadcast of information [Cohen (1994)]. Hence, the rush to virtualize education may in fact be a retreat toward outdated and less-effective instructional methods.

This research attempts to "raise the bar" for distance learning by moving from a classroom transmission metaphor to a collaborative learning metaphor. Collaborative learning techniques have been shown to be consistently superior to traditional classroom lecture both in effectiveness and in student satisfaction [Cohen (1994); Johnson and Johnson (1994)].[1] However, collaborative learning is highly dependent on communication, or *discourse*. Given past research showing breakdowns in video-mediated communication, we designed this research project to find out whether video-mediated communication could support the rich social discourse required for collaborative learning.

[1] Johnson and Johnson's work focuses specifically on the contrast between cooperative and competitive learning environments. Since the notion of cooperation is inherent in collaborative learning, their research can also be applied to collaborative learning environments. Both cooperative learning and collaborative learning are built around the idea of socially constructed knowledge.

The collaborative learning method chosen for this study is Tutored Video Instruction (TVI). TVI was invented at Stanford University over twenty years ago as a means of providing graduate-level engineering courses to working engineers employed by local high-tech companies. In TVI, a small group of students play a pre-recorded videotape of a classroom lecture. During the playing of the tape, a facilitator encourages the students to pause the tape to ask questions or discuss topics. As with other forms of collaborative learning, TVI students have been shown to outperform students who physically attended the lectures [Gibbons, Kincheloe, & Down 1977].

Duplicating the success of TVI in a video-mediated environment is a significant challenge for the technology. Like other forms of collaborative learning, TVI groups generate frequent and complex social interaction among group members. Students in TVI use discourse not only to negotiate meaning, but also to negotiate relationships with group members. Much of the communication used to create the social aspects of TVI is non-verbal in nature. So where video has been shown to be much less important than audio in broadcast learning environments, it plays a crucial communication role in TVI. The purpose of this study is to determine whether these rich communication patterns and relationships can be created in a video-mediated environment specifically designed to mimic face-to-face TVI. The virtual version of TVI created for this experiment was called "Distributed Tutored Video Instruction," or DTVI.

Theoretical Framework

Research into virtual distance learning crosses many theoretical domains. The issues can be examined from at least three very different fields: education, psychology, and technology. Within each of these fields, we find competing explanations and theoretical languages with which we might explain Distributed Tutored Video Instruction. Rather than try to survey all of these domains, we have chosen particular bodies of research within these domains that we believe provide a useful groundwork for exploring virtual collaborative learning.

Collaborative Learning

The finding that students in collaborative learning environments outperform students in non-collaborative environments is one of the most robust findings in all of educational research [Johnson and Johnson 1996]. We refer to this phenomenon as the "collaborative learning effect." As an instructional strategy, Tutored Video Instruction clearly falls under the rubric of collaborative learning.

Various theories have been devised to explain the collaborative learning effect. Among those we consider most useful are

1. The small group environment provides more "air time" for students. That is, it provides more opportunities for students to ask questions and thus acquire new information.[2]

[2] The "information transfer" metaphor for learning on which this theory is based has largely been supplanted by "constructivism," in which what a student does with information is seen as more critical than the information content itself.

2. During collaborative learning, students make public conjectures about their knowledge. The feedback from other students helps group members refine their ideas even further, particularly if the discussion involves some degree of controversy.

3. The social necessity to communicate their ideas requires students to articulate and elaborate their knowledge to others. The acts of articulation and elaboration encourage the active use of the conceptual content and thereby increase learning.

4. Students in collaborative groups exhibit helping behaviors—offering emotional encouragement, tutoring, sharing notes, etc.—that increase learning, particularly for less able group members.

5. Collaborative learning leads to increased receptivity to learning by increasing motivation and attention

We believe that all of these factors are at work in collaborative learning environments.

It is important to note also that there are varying definitions and degrees of collaborative learning. Some definitions of collaborative learning explicitly include training in collaboration, assigning specific roles for group members, or group-oriented assessment. The nature of the group and the personality of group members will also have an impact on degree of collaboration. Because of these factors, collaboration in a learning environment is best viewed on a continuum. On the low end of the continuum, a group might be brought together involuntarily, might have members who do not value collaboration, and might be given tasks and assessment that discourage collaborative behavior. At the high end of the continuum, a group might be created voluntarily, might be trained in specific collaborative techniques or have formal roles assigned, might be asked to complete tasks that require cooperation, and might have their individual assessment tied to those of their group members.

Tutored Video Instruction, at least as implemented in this experiment, lies near the middle of this continuum. Participation in the experiment was voluntary: since students knew that the experiment involved small group collaborative learning, it is reasonable to assume some degree of self-selection. That is, students predisposed toward collaboration or who believed that the small group environment would be more enjoyable or would help them academically were more likely to volunteer. This would tend to increase the amount of collaboration compared to groups that were selected randomly. On the other hand, the learning tasks and assessment were the same as those used for the standard university courses, which tend to be very individualistic in nature. Thus there were no structural incentives for collaboration other than the bond the group formed as a by-product of the TVI process.

Discourse

Discourse is the medium for collaborative learning in the TVI process. Discourse serves two distinct but related functions. First, through discourse the group member's understanding of the lecture is expressed and refined through interaction with peers. We refer to the expression of the conceptual content of the course as the “content” function of discourse.

Recent work in math and science education has shown that students who articulate their current state of understanding perform better on outcome measures than students who remain silent [Webb (1991)]. For example, student explanations of content to their peers produced greater benefit for the explainer than the explainee [Swing and Peterson (1982)]. Similarly, the necessity to construct a rationale for one's assertions during a disagreement provides another social impetus for articulating one's knowledge. These interpretive conflicts play a prominent role in the conceptual development theories of both Vygotsky and Piaget. Engaging in discourse to resolve these interpretive conflicts correlates positively with achievement [Lehrer & Smith (1986); Clements & Nastasi (1988)].

Second, it is through discourse that group members negotiate relationships and build trust. We refer to the use of discourse to build social ties as the "relational" function of discourse. Articulation and elaboration are examples of content-oriented discourse, but they are evoked by a variety of social situations. Requests for help, clarifications, disagreements, explanations, and justifications of one's assertions are all examples of the social discursive mechanisms that arise in collaborative learning. For these promotive interactions to occur, the group must develop and maintain sufficient cohesion to minimize the potential risks of losing face in the eyes of one's peers as a result of being mistaken or ignorant about the course content [Johnson & Johnson 1989]. The development of this climate of trust is the result of ongoing expressions of genuine positive regard for each other. The resulting members' sense of "mutual rewards through mutual caring" determines the cohesiveness of the group. By reducing the risks of publicly acknowledging one's lack of knowledge, groups with high cohesion exhibit more proactive discourse, which encourages member articulation and elaboration. It is only through acknowledging what one doesn't know that one can mobilize the resources to develop the necessary knowledge. According to Johnson and Johnson (1996),

> *Learning communities are based as much on relationships as they are on intellectual discourse. The more positive the relationships among students and the more committed students are to each other's success, the harder the students will work and the more productive they will be. p.1024*

While content-related discourse is primarily verbal, relational discourse includes all the subtle non-verbal behavior that accompanies talk. In this parallel discourse channel, orienting one's body to face the speaker, leaning forward on the edge of one's seat, and nodding affirmatively are all ways of stating with one's actions an ongoing commitment to the speaker. Conversely, staring off into space, attending to something else while the speaker is talking, and starting a side conversation while being spoken to are all examples of actions that may communicate a lack of interest in the speaker. Through direction of eye gaze, facial expression, gesture, and voice intonation, this parallel discourse channel continually carries relational information about the members' feelings for each other and their level of engagement in the group's activity.

Implicit in our description of discourse is a reciprocal covenant to attend to the other speaker and to make an effort to contribute to the progress of the discourse. The mutual expectation of discourse partners to be responsible for moving the

conversation along in a productive manner are summarized by *Grice's Conversational Maxims* [Grice 1975]:

Cooperative Principle. Make your conversational contribution when it is needed in accordance with the accepted purpose of the conversation in which you are participating.

Maxim of Quality. Make your contribution truthful; do not state that which is false or that for which you have inadequate support.

Maxim of Quantity. Give as much information as needed for the purposes of the exchange and only that information.

Maxim of Manner. Be perspicuous; avoid ambiguity and obscurity; and be orderly and brief.

Maxim of Relevance. Make your remarks relevant.

These interactional maxims form an implicit covenant to which discourse participants hold each other accountable. Presumably, if one makes a series of good conversational moves, one will be invited to contribute to other conversations. Conversely, make a series of conversational moves that violate these maxims and one will be excluded from future conversations.

Note that all of the criteria contained in *Grice's Maxims* relate to the content of the conversation. With our joint focus on language as content and relational action, we will require a conversational maxim that addresses the relational dimension of discourse explicitly. We will add Bach and Harnish's *Politeness Maxim* [Bach & Harnish 1979], which emphasizes the importance of "preserving face" through discursive action. For our purposes, saving face means preserving the expectation that everyone is capable of contributing to an ongoing conversation. Any action by a participant that violates these maxims places the participant at social risk in terms of future dealings with peers. This follows from the perception that the offending individual hasn't lived up to his contractual obligations, which diminishes his social capital in the eyes of his peers. From our perspective, the minimum participant commitment is to display nearly continuous orienting behavior to the ongoing conversation. Obviously, adherence to these conversational maxims is central to achieving the proactive discourse that fuels the collaborative learning effect.

In summary, all five of the theories we have suggested for the collaborative learning effect rely on discourse. The first three—gaining additional information, getting feedback on public conjectures, and articulating and elaborating conceptual knowledge—rely explicitly on content discourse. But the willingness of group members to ask questions, elaborate their understanding, or challenge another group member's understanding is based on a supportive group climate, which is created through relational discourse. The second two explanations—helping behaviors and psychological engagement—are a direct result of relational discourse and the group cohesion it fosters.

Video-Mediated Communication

Given that the collaborative learning effect is built on content and group-oriented discourse, the ability of a technology to support all of the subtle aspects of human communication is a serious issue for collaborative distance learning. Recent studies

of collaborative work done at a distance over a video link have found that there are subtle and unexpected communication difficulties encountered by participants attempting to coordinate their efforts through these systems. Issacs and Tang (1993) reported that participants using the prototype *ShowMe*™ from Sun Microsystems had difficulty in the real-time management of a number of social behaviors that support conversations, such as turn-taking and the coordination of joint attention through eye-gaze. For many of the same reasons, Fish, Kraut, Root, and Rice (1992) in an evaluation of AT&T's video telephone, *Cruiser,* state:

> *In essence, users reported that during Cruiser conversations they mostly prepared for work, while during face-to-face conversations they actually performed the work. Why was this? Time and again users said they used face-to-face communication rather than the Cruiser system because the Cruiser system was not able to support all the communication demands of conventional work activities. p.41*

Communication breakdowns resulting from technology-mediated communication can typically be attributed to three causes:

Network transmission artifacts. Low frame rate, audio and video latency, and artifacts from information compression have been shown to affect people's preference for the media, as well as how they interact through it [Kies, Willinges & Rosson (1996); Isaacs & Tang (1993)].

Reduced image size. Image size may adversely effect conversation patterns [Monk & Watts (1995)] and the willingness of individuals to interact with remote collaborators [Fish, Kraut, & Chalfonte (1990)]. Storck and Sproull (1995) found that students who view their peers through video give them lower competency ratings than they give their co-present peers. Diminished image size can also increase the perceived social distance of collaborators, which may effect trust [Rocco (1998)].

Diminished directionality cues from eye gaze. Difficulty in establishing the location of participants' gaze has been linked to various perturbations in the communication process. These, include exaggerated gestures and staring [O'Conaill, Whittaker & Wilbur (1993); Colston & Shiano (1995)], more formal speech with fewer overlapping utterances [Monk & Watts (1995); Gale (1998); Cohen (1994); Sellen (1992)] and difficulty in managing group speech issues such as turn-taking and maintaining or acquiring the floor [Isaacs & Tang (1993)].

To the extent that the DTVI system reproduces these problems, we would expect that the collaborative learning processes of DTVI groups would be compromised when compared to their face-to-face TVI equivalents.

DTVI System

The DTVI prototype was designed to simulate a face-to-face TVI session as closely as possible. The system uses an open microphone architecture in which anyone can speak and be heard at anytime. Students wear stereo headphones with a built-in microphone attached. The group discussion plays in one ear while audio from the course videotape plays in the other. Students can adjust the volume of the two channels independently. They can also mute the microphone.

Analog video distribution was chosen for the prototype to achieve full 30-frames per second (TV quality) video with no compression artifacts or perceptible latency. This idealized environment allowed us to study the learning process without worrying about the effect of digital transmission artifacts.[3]

Real-time video of each participant's face and upper body is delivered from a camera positioned beside the monitor. These images are arrayed in individual cells of a 3x3 "Brady Bunch" matrix (see below). The matrix displays as an analog video overlay on a 20-inch computer screen. Videotape of the course lecture plays in the lower right cell. Because of the 3x3 matrix limitation, a maximum of seven students (and one tutor) can participate in a DTVI session. Individual cells of the matrix cannot be resized, but students can go back and forth between watching all nine cells or exploding a single cell to take up the full window. The video window itself is also fully movable and resizable.[4]

The tutor controls the VCR that plays the course video. Students can verbally request that the tutor pause the tape or can send a pause request message to the tutor by pressing a button on the user interface (the verbal method was by far more common). Later versions of the DTVI software allow students to send private text messages to the tutor. This feature was provided primarily as a way for students to notify the tutor of technical problems when the microphone wasn't functioning correctly. We resisted the temptation to add additional features to the software because we wanted to maintain the direct comparison between TVI and DTVI.

[3] There were some problems with video quality at one of the two participating universities (Cal Poly had problems with video static). This was the result of using the existing cable TV infrastructure. The worst of these problems were resolved after the second quarter the system was used. Since the problem was only at one of the two universities, was only in the video domain and did not involve latency or lowered frame-rate, we do not believe that it had any impact on the results of the study

[4] At Cal Poly, the system was configured for a maximum of six students, with one cell left empty. Also, on the Cal Poly DTVI system there was a second video window that always displayed the course video tape.

Hypotheses

Given the potential for video-mediated communication technology to interfere with both content-oriented and relational discourse, we designed the experiment to compare Distributed TVI with face-to-face TVI to try to discover the impact of the technology on learning and on discourse. If the DTVI system did interfere with discourse, we would expect to see evidence of the following:

1. TVI students would outperform DTVI students academically and the collaborative learning effect (the performance gap between collaborative students and lecture students) would be smaller for DTVI students than for TVI students.
2. DTVI students would have lower levels of satisfaction with the collaborative learning process.
3. DTVI groups would have lower frequency of discourse.
4. DTVI students would exhibit lower levels of group cohesion.

All statistical procedures were based on the null hypothesis that there was no difference between TVI and DTVI on measures of these items.

Description of the Experiment

The experiment was conducted with over 900 students at the California Polytechnic University at San Luis Obispo (Cal Poly) and at the California State University at Chico. About half of these students volunteered to take regular university courses via small group collaborative learning instead of the typical university lecture. The other half remained in the classroom lecture sections to create a baseline against which we could compare collaborative learning outcomes for the courses in the experiment. A total of 216 students took the course using the prototype DTVI system that was designed for this research project. DTVI students were assigned separate cubicles and "met" via video conferencing technology. Another 232 students participated in face-to-face TVI groups.

TVI and DTVI groups watched identical videotapes of the course lecture. In most cases, the video tapes are made by recording the current semester/quarter's regular classroom lecture, ensuring that the TVI and DTVI students receive exactly the same course content as classroom students. In a few cases, tapes from previous semester/quarters were used or the instructor made tapes in a studio without students present. For both TVI and DTVI, the tutor paused the tape for discussion at key points in the lecture or whenever a student had a question. Frequently, students also carried on discussions while the tape was running. To allow time for discussion, each TVI and DTVI session was scheduled for a longer block of time than that of the

original lecture. At Cal Poly, session time was increased by 50%. At Chico, scheduling constraints allowed for an increase of approximately 25%.[5]

All students participating in the experiment received the same course assignments and tests as the classroom students and were graded using the same procedure. Previous TVI research suggests that the tutor is an important variable in the success of TVI groups. To control for tutor effects, all tutors led both a TVI section and a DTVI section each quarter/semester they participated in the experiment.

Students

Students were recruited to participate in the experiment on the first day of class.[6] A brief presentation on the research project was made to the lecture group. Students interested in participating were led out into a separate room. The experiment was then explained in more detail and students were advised of the session video taping and measurement instruments they would be asked to fill out if they decided to participate. After the explanation, any students who decided not to participate were allowed to return to the lecture class. In most cases, assignment to TVI or DTVI conditions was done randomly from the pool of volunteers. Students signed up for a time slot without knowing whether it was a TVI or a DTVI group. Students who had concerns about the condition to which they were assigned were allowed to switch to the other condition, but this occurred extremely rarely. In a few cases, the instructor let students know which sections corresponded with which conditions. But even in these cases, assignment to TVI or DTVI conditions seemed to be driven more by students' existing schedules than by their preference for one method or the other.

Given that the real world nature of the experiment prevented us from doing completely random assignment to conditions, we asked students to complete a brief demographic survey before the start of the experiment. The table below shows that TVI students and DTVI students were in fact very similar in those attributes that we might expect affect academic performance in a collaborative learning environment. None of the variables in the demographic survey (except GPA) showed any statistically significant correlation with final grades.

[5] The Chico TVI and DTVI sections were scheduled for the same amount of time as the lecture class under the assumption that the lecture classes consistently finished early whereas the collaborative learning students would continue until the end of the scheduled period. Past TVI research suggests that not allowing adequate time for discussion can reduce the effectiveness of TVI. We do not know to what extent the Chico time constraint affected the overall performance of the TVI and DTVI groups, but since both conditions had the same time constraints, we believe the effect on the TVI/DTVI comparison is minimal. However, the time constraint may have hurt the collaborative students in comparisons with the lecture students.

[6] Some of the experimental sections of the course at Cal Poly were listed directly in the course catalog with the regular course number plus an "X" to designate an experimental section but without any indication of whether the section was TVI or DTVI.

Demographic Profile	TVI	DTVI
Male	59%	63%
Average years in college	3.21	3.29
GPA (Grade Point Average)	2.86	2.85
English as first language	83%	89%
Prior distance learning experience	8%	13%
Prior peer study group experience	33%	42%
Average hours of computer use per day	2.5	1.9

We were not able to give the lecture students a demographic survey. The only thing we know about them is their GPA and the final course grade. The GPA for students who remained in the lecture was 2.76, significantly lower than that of the collaborative learning students. It appears that students with more academic ability were more likely to volunteer for the experiment. We controlled for GPA in all statistical procedures involving course grade.

Tutors

Tutors were graduate students or advanced undergraduate students who had already taken the course. Instructors were encouraged to choose students who they believed would make good facilitators as tutors. However, in some cases, assignment as a tutor seemed to be more a function of how familiar the instructor was with the prospective tutor rather than skill as a facilitator. Many tutors participated in the project for more than one quarter/semester. However, no course had the same set of tutors for the entire experiment (except the Management course at Cal Poly, which ran only one quarter).

Tutors receive between one and four hours of training on the TVI/DTVI process. During this training, tutors were encouraged to avoid taking an instructor-like role in the group. For instance, they were encouraged not to answer student questions directly, but rather to redirect the questions back to the group to see if group members could work out the solution. The ability to be a good facilitator is largely related to personality so, despite the training, some tutors had an easier time than others did in the role. For a few tutors, the facilitative role was complicated by the fact that they also served as lab instructors for the course. Tutors were not supposed to grade the students in their groups, but we know of at least one case where an instructor required that a tutor grade papers for the class .[7]

[7] Interestingly, this tutor reported that when the students found out he was grading their papers, his relationship with the students deteriorated.

Courses

The students in the experiment are enrolled in regular university courses. Six different courses were used—four at Cal Poly and two at Chico. The courses spanned a wide variety of subject matter. All but one were undergraduate courses. Because of the need to draw from a large pool of students, most classes were introductory courses where class size is typically large. The courses are discussed in more detail in the "Outcomes" section of the report, where TVI/DTVI grade comparisons results are broken down on a course-by-course basis.

Data

We collected three types of data for our research: academic results, survey data, and logging data. Each of these data streams is defined in more detail below.

Academic Performance

We used final course grade to assess the academic performance of TVI and DTVI students. We also gathered demographic information about each student, including data about age, gender, year in school, major, English language proficiency, prior exposure to distance learning or study groups, and other relevant information (for a complete list of items on the demographic survey, see Appendix A). Since we could not use true random assignment to experimental conditions, we used this data to assess the similarities between TVI and DTVI groups. We also looked for correlations between demographic variables and achievement to see if different categories of students responded differently to TVI and DTVI. Finally, we gained access to university records so we could control for GPA (as measured at the beginning of the course) when assessing student academic performance.

Surveys

We asked students to fill out surveys at various points during their TVI or DTVI experience. These surveys gauged students' satisfaction with the experience as well as how they felt about particular elements of their collaborative learning experience. The majority of survey items consisted of Likert scale items, using a balanced, 7-point scale. For example, a "1" would indicate strong disagreement, a "4" would be neutral, and a "7" would indicate strong agreement with a question. On one instrument, we employed a forced choice format in which DTVI participants were asked to select in which setting, DTVI or face-to-face, it would be easier to carry out an imaginary user intention. To discourage students from making arbitrary selections as a result of the forced choice format, we included a third alternative, "no difference." Appendix A provides an overview of the survey instruments used. It also contains tables showing when each instrument was administered and a copy of each of the actual survey instruments.

Logging Data

During the course of the experiment, we created a database of information on group discourse. To do this, we videotaped each TVI and DTVI group several times during the quarter/semester. We then had the tutors watch the videotapes of their own sessions and enter data about each "exchange" into a database. "Exchange" is the

term we used for a sequence of conversational turns on the same topic or a stream of related topics. We defined operationally an exchange as any discussion occurring while the course videotape was paused, or any discussion with four or more conversational turns that occurred while the course videotape was running. For each exchange, we noted how long the conversation lasted, who initiated it, who participated, who was critical, and whether the exchange included humor, a technical breakdown, or was a "critical incident" in the group learning process. Then we used a small number of trained "counters" to tally how many conversational turns occurred in each exchange in each of four categories: tutor questions, tutor statements, student questions, or student statements.[8] All of this information became a part of what we refer to as the "logging database."

In addition to the quantitative information collected for logged exchanges, we had tutors enter qualitative assessments of the value of each exchange with regard to content or relational (group-building) discourse. Ratings were on an integer scale of -2 to +2. The "group" dimension referred to how the exchange affected the group chemistry or cohesion. Ratings of 0 indicate the exchange was neutral, or had no particular effect on group cohesion. A negative score means it harmed the group chemistry. A positive score means it helped. The same scale was used to rate the "content" value of the exchange, or how likely the exchange was to help group members perform better on an exam. A negative "content" rating might be given if the exchange left group members more confused or if the group arrived at an answer that turned out to be wrong. These ratings were also entered into the logging database.

Database

The academic data, survey data, and logging data from the two universities were combined into a single relational database. The data was then "cleaned" to eliminate data entry mistakes and variations in data entry conventions. Students for whom we had no final course grade were eliminated, as were groups whose average attendance was fewer than four students (since this did not meet our definition of collaborative learning). It is from this database that the statistics and analyses in this report were generated. The database itself is available as an adjunct to this report.

[8] Independent counters were used to minimize problems with inter-rater reliability. The Spearman Rho correlation coefficient for counters was .80. It was not practical to use independent raters for other process variables because the rating process required a knowledge of the course content and the evolving relationships between individuals in the group.

Part 2: Learning and User Satisfaction

Comparison of Academic and User Satisfaction Outcomes for TVI , DTVI, and Lecture students

Academic Performance

To assess academic performance, we converted final letter grades for the course into numbers based on a 4.0 grading scale. We then ran an analysis of variance (ANOVA) using course and method as experimental factors and incorporating overall GPA (as measured at the start of the course) as a covariate. As the table below shows, the mean grade for TVI students and DTVI students is nearly identical while the mean grade for lecture students is lower.

Estimates with GRADE as Dependent Variable

Method	Mean Grade	Std. Error
Lecture	2.83	.052
TVI	3.14	.057
DTVI	3.13	.060

Pairwise Comparisons based on estimated marginal means

Method I	Method J	Mean Difference (I-J)	Std. Error	Significance	95% Confidence Interval	
					Lower Bound	Upper Bound
Lecture	TVI	-.305*	.077	.00	-.491	-.120
	DTVI	-.291*	.079	.00	-.481	-.101
TVI	DTVI	.0144	.082	.861	-.183	.212
	Lecture	.305*	.077	.00	.120	.491
DTVI	TVI	-.0144	.082	.861	-.212	.183
	Lecture	.291*	.079	.00	.101	.481

* Significant at the .05 level

A pairwise comparison shows that TVI and DTVI means are not significantly different from each other at the .05 level (p=.861) and that both the TVI and DTVI mean are significantly different from the lecture mean (p=.000). Virtualizing TVI does not appear to lessen the collaborative learning effect, at least as measured by course grade

We also looked at grades on a course-by-course basis. As mentioned previously, there were six courses used in the experiment. The courses are described briefly below.

Architecture — Arch (Cal Poly)

The title for the architecture course is "Materials of Construction". The course analyzes the properties of various construction materials, and their deployment in solving a variety of construction dilemmas. The knowledge of the strengths and weaknesses of these materials in the construction process informs subsequent course work in architectural design. The course enrolls between 200 and 300 students per term. Unlike the other courses, most of the lectures are delivered via videotape to the classroom lecture students as well.

Media Aesthetics — CDES 40 (Chico)

CDES 40 is an introductory course on the recognition and interpretation of visual and audio aspects of media production. Here students learn about the production elements—mainly directing and editing decisions—that are involved in constructing films and video. During lectures, production techniques are first described and then illustrated through the showing of video excerpts from movies. Grades are determined by multiple choice exams which make reference to both the production techniques and the clips that illustrated them. Attendance is also factored into the final grade.

Telecommunications Industry — CDES 65 (Chico)

This course covers the technological, historical, and legal development of electronic media in America. A core course for media arts majors, the course is fact intensive. The instructor moves through a steady stream of transparencies during each lecture and students are taking notes continually. Grades are determined by multiple choice exams and a class presentation. The presentations, done in the last third of the semester, necessitate that the DTVI groups meet physically face-to-face in order to produce the videotaped presentations which are shown to the lecture section of the class.

Materials Engineering — MATE (Cal Poly)

This introduction to Materials Science consists primarily of lectures on the physical properties of materials. Periodically, physical examples of specific materials under discussion are circulated through the lecture hall. TVI and DTVI participants did not have access to those “hands on” exhibits. Grades were determined by weekly quizzes plus a midterm and a final multiple choice exam. Students who had enough points for an A before the final exam were not required to take the final. Since being absent on the day of a quiz resulted in a score of zero for that quiz, the final grades were influenced by attendance.

Business Management — MGT (Cal Poly)

This course, which ran only one quarter, is part of the MBA program at Cal Poly. It was the only graduate-level course in the study. No lecture section was offered.

Management Information Systems — MIS (Cal Poly)

This business course, which is an introduction to Management Information Systems, is designed to acquaint students with the application of computer systems to businesses. Besides lecture, this class had a laboratory component in which students completed computer projects. For DTVI groups, this means the participants, who would normally be isolated from each other, worked together physically twice a week. Tutors served as lab instructors, which somewhat complicated their role as facilitator during the TVI/DTVI sessions. Grades were determined by multiple choice exams combined with laboratory project scores.

The table below gives descriptive statistics for student grades broken down by course and method.

Descriptive Statistics

Method	Course	Mean Grade	Std. Deviation	N
Lecture	ARCH	2.67	1.01	34
	CDES 40	2.65	.918	134
	CDES 60	2.85	.955	97
	MATE	3.46	.702	30
	MIS	2.33	.732	24
	Total	2.76	.942	319
TVI	ARCH	3.37	.721	17
	CDES 40	2.60	.725	25
	CDES 60	2.96	.810	37
	MATE	3.02	1.17	45
	MGT	3.94	.123	20
	MIS	3.22	.605	63
	Total	3.14	.857	207
DTVI	ARCH	3.04	.625	15
	CDES 40	2.93	.645	26
	CDES 60	2.91	.864	32
	MATE	3.09	.868	42
	MGT	3.86	.286	18
	MIS	3.21	.670	57
	Total	3.14	.759	190
Total	ARCH	2.94	.906	66
	CDES 40	2.68	.862	185
	CDES 60	2.88	.904	166
	MATE	3.16	.973	117
	MGT	3.90	.217	38
	MIS	3.07	.727	144
	Total	2.97	.891	716

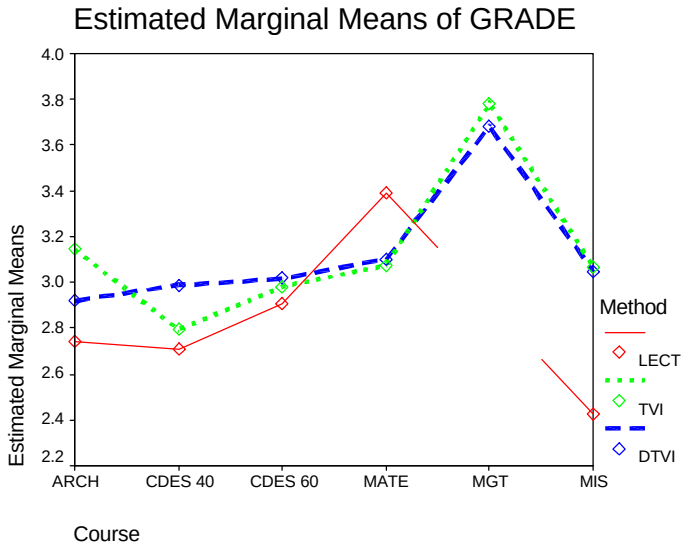
A test of between subject effects indicates that mean grades vary significantly both for method (METHCODE) and for course (CRSCODE) and that there is significant interaction between method and course. In other words, grades were significantly different between courses and the impact of instructional method also varied by course.

Tests of Between-Subject Effects
Dependent Variable: GRADE

SOURCE	Type III Sum of Squares	df	Mean Square	F	Sig.	Eta Squared	Noncent. Param	Observed Power**
Corrected Model	186 *	17	10.95	20.1	.000	.328	341	1.00
Intercept	18.9	1	18.9	34.6	.000	.047	34.6	1.00
GPA	104	1	104	190	.000	.214	190	1.00
METHCODE (Lecture/DTVI/TVI)	3.85	2	1.93	3.53	.030	.010	7.06	.657
CRSCODE	26.2	5	5.25	9.61	.000	.064	48.1	1.00
METHCODE * CRSCODE	10.7	9	1.19	2.18	.022	.027	19.6	.892
Error	381	698	.546					
Total	6890	716						
Corrected Total	567	715						

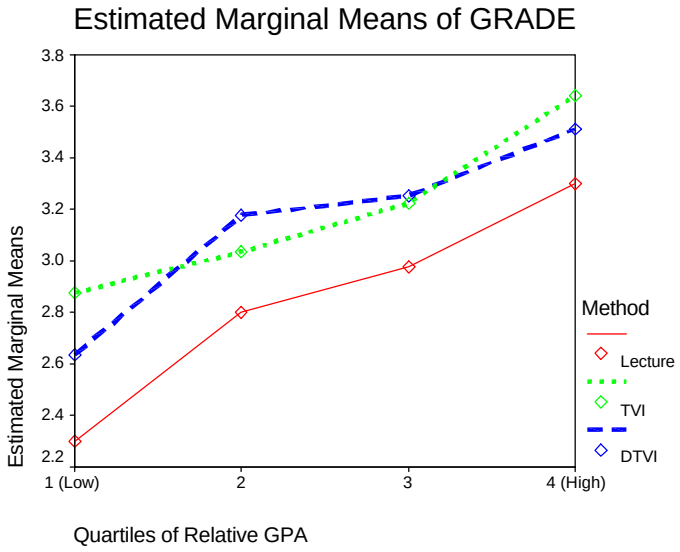
* R Squared = .328 (Adjusted R Squared = .312)
** Computed using alpha = .05

Below is a graphical representation of the student performance by method and course.



Note that for MATE (Materials Engineering), the one course where lecture students outperformed the collaborative students, there are multiple quarters of data for the TVI and DTVI students but only one quarter of data for lecture students. If we limit the analysis to the quarter for which we have data on all groups, the gap between lecture and collaborative students largely disappears. This suggests that there was some drift in grading policies for that class from quarter to quarter, which is very possible since different graders were used. Note that the benefits of collaborative learning show up most markedly in courses that deal with conceptual and applied knowledge (Architecture, MIS). Collaborative learning was less of an advantage in courses like MATE and CDES 65 (Telecommunications Industry) that were largely fact-based and taught by instructors with a very traditional teaching style. Because MGT (Management) was a graduate level course, the spread of grades was very narrow and the grade average was much higher than for other courses.

Besides looking at grades by course, we looked at whether students of varying academic ability responded differently to TVI and DTVI. We sorted students into quartiles based on their GPA relative to other students in the same course. The chart below shows the mean grades for students in each quartile:



For both TVI and DTVI students, the collaborative learning effect held for students of all levels of academic ability.

Student Satisfaction

Overall Satisfaction

While grades are perhaps the most important measure of student achievement, there are other important dimensions for gauging the effectiveness of interaction across the two systems. Since we are interested in how interacting through the DTVI interface might alter the collaborative learning experience, we will begin by examining students' overall satisfaction. The questions below ask both how much students enjoyed the processes and how much they thought they learned compared to

traditional classes. We also asked whether students would choose to take TVI or DTVI courses again and whether they would recommend them to other students. Using our balanced 7-point Likert scale, a mean above 4 indicates that the participants answered in the affirmative.

Question	TVI n	DTVI n	TVI Mean	DTVI Mean	P-Value
Taking the course in a small group was much more enjoyable than attending the lectures. [1 = disagree, 7 = agree] (EQ3 2)	38	39	6.42	5.82	.046
I learned more in this format than I would have in the lecture section. [1 = disagree, 7 = agree] (EQ3 3)	38	39	5.39	5.03	.366
I would take another lecture class using this method. [1 = disagree, 7 = agree] (EQ3 1)	39	41	5.87	5.15	.083
I would recommend this class (and the way it was taught using technology) to others. [1 = disagree, 7 = agree] (EQ1 24)	119	106	5.73	5.60	.528

Ratings of the collaborative learning process were high for all students. For two of the four questions, there was no statistically significant difference between TVI and DTVI. When asked whether they would take a course using this method again, TVI students responded slightly more favorably than their DTVI counterparts, but the difference in means was only significant at the .10 level. The biggest difference was in enjoyment, where TVI students' ratings were remarkably high—6.4 on a 7-point scale. DTVI students rating were also high (5.8), but the difference between TVI and DTVI was statistically significant at the .05 level. Note that for all four questions, the means were higher for TVI students than for DTVI students. While both TVI and DTVI students in the experiment clearly preferred collaborative learning to a typical lecture, the TVI students were a bit more satisfied with the overall experience.

Technology

In addition to asking about overall satisfaction, we asked students about the impact of the technology on their learning.:

Question	TVI n	DTVI n	TVI Mean	DTVI Mean	P-Value
I felt that I was not able to fully participate in this class because of the technology. [1 = disagree, 7 = agree] (EQ1 26)	117	103	2.50	2.62	.567
It was easy for me to see the lecturer's transparencies and displays. [1 = disagree, 7 = agree] (EQ3 6)	38	39	4.97	4.18	.069

TVI students and DTVI students did not respond significantly differently when asked whether the technology inhibited their ability to fully participate in the class. Neither group felt the technology was a significant barrier. This is good evidence of the ability of the DTVI system to support the collaborative learning process. The similarity in scores for TVI and DTVI on this question is particularly interesting since the DTVI students were using considerably more technology than their TVI counterparts whose technology consisted of a VCR and TV. The closeness in ratings may suggest that the biggest technology impact is the one experienced by both

groups—remoteness from the lecture. Once students accepted the distancing inherent in distance learning, the transmission technology didn't seem to matter much.

On the other hand, it's worth remembering that our audio and video transmission were idealized by using a distribution system where network transmission artifacts could be easily avoided. It is unclear how students would have felt about the technology if the transmission quality were to be degraded in ways endemic to real world networks.

The second question focuses on one of the most obvious potential limitations of the DTVI technology. As a result of both display size and resolution, it is harder to read an overhead transparency or chalk/whiteboard from a videotape. The problem could be even worse when the video is displayed in a window of a computer monitor. In fact, DTVI students did report that it was more difficult to see the lecturer's transparencies and displays, although the small difference was significant only at the .10 level. However, the good news is that the actual rating for ease of seeing displays was at the mid-point of the 7-point scale. This suggests that the students did not see the problem as critical.

We also wanted to know to what extent the DTVI system might have created a "Hawthorne Effect" that would color the attitudes of DTVI students. We asked the following two questions:

Question	DTVI n	DTVI Mean	DTVI S.D.
Using "cutting edge" technology made the course more interesting. [1 = disagree, 7 = agree] (EQ3 52)	39	5.31	1.72
How many sessions did your fascination with the technology last? [1 = "1 or 2", 2 = "3 or 4", 3 = "5 or 6", 4 = "7 or 8", 5 = "9 or 10", 6 = "11 or 12", 7 = "13 or more"] (EQ3 57)	39	2.92	2.08

These questions show that the "newness" of the DTVI technology did have an impact on students' feelings about their experience. On the second question, the 2.92 mean translates to about five weeks, meaning that fascination with the technology lasted from a third to half of the term.[9] Since it is difficult to quantify the possible impact of a Hawthorne Effect in the experiment, we will simply note two things. First, many of the survey instruments were delivered after the fifth week of the term, which would make it less likely that the novelty of the technology had an effect on student responses. Second, the TVI students were made to feel like full participants in this experiment, so it is possible that a Hawthorne Effect also colored their responses. That means comparisons between TVI and DTVI would be less likely to be affected by a Hawthorne Effect than comparisons between collaborative learning conditions and lecture. Given these facts, we do not believe that a Hawthorne Effect significantly colored the results presented here.

As mentioned earlier, our theoretical framework suggests that video will be more important in collaborative learning than it has been in previous educational studies based on one-to-many instruction. The increased importance is a result of the non-

[9] Since one campus is on the semester system and the other on the quarter system, the terms were different lengths.

verbal communication that engenders trust and group cohesion, which are essential to collaborative learning. We asked students about the relative importance of the audio and video channel.

Question	DTVI n	DTVI Mean	DTVI S.D.
My primary connection with my group was through my headphones rather than through the "Brady Bunch" squares. [1 = disagree, 7 = agree] (EQ3 53)	39	4.59	1.85
What percentage of the group's conversations took place while your course window was enlarged? (EQ3 62)	39	29.18	29.87

On the first question, the rating shows a slight tendency toward audio as the most important channel for connecting with the group. But the smallness of the gap does indeed suggest that the video channel plays a relatively strong role in collaborative learning. The second question is important because the students must choose between watching the video tape window or the Brady Bunch window showing other group members. If the visual connection to group members was not important, students might be inclined to simply keep the course window containing the video lecture enlarged at all times. Instead, students reported that they watched their fellow students about two-thirds of the time during conversations. The results from both of these questions support the premise that non-verbal communication plays an important role in students' connectedness to their groups.

Part 3: Discourse

Exploring of the Differences in Discourse Patterns between TVI and DTVI

The Role of Discourse in Collaborative Learning

Discourse is fundamental to collaborative learning. As noted in our theoretical framework, discourse serves two functions. First, it is the medium for information exchange. Instructors and tutors explain concepts and answer questions. Students ask questions, offer public conjectures, receive feedback on their ideas, and answer other students' questions. But students also use discourse to entertain, express regard for group members, encourage, and help each other stay awake and alert. These relational functions of discourse sometimes contribute to learning in their own right. But more often, they are the enablers that support and encourage content-oriented discourse and active construction of knowledge. It is this emphasis on relational discourse that distinguishes collaborative learning from other learning models. If DTVI is to preserve the collaborative learning effect found in face-to-face TVI, it must be able to support the full spectrum of both content-oriented and relational discourse.

The line between content discourse and relational discourse is not always clear. For example, Johnson & Johnson (1996) list academic controversy as a fundamental mechanism of collaborative learning. Resolving a difference of opinion forces participants to link additional knowledge to the disputed facts through the social discourse acts of justification and explanation. Through this process, new facts are uncovered and new knowledge structures formed by integrating the additional information contained in the conversational exchange into students' conceptual frameworks. In this sense, academic dispute falls in the content domain. But there is also a relational component of these interchanges that is expressed non-verbally in real-time. For these disagreements to be productive, the members have to have enough trust in each other to be able to take each other's perspective and explore the entailments of their respective positions. If the expression of proactive relational information is curtailed by the DTVI interface, students may be less willing to consider the contending positions, resulting in entrenchment of one's current view, rather than exploration of` alternative views. Therefore, without adequate support for relational discourse, the collaborative learning benefits of academic controversy would not be realized.

In our analysis of discourse, we use face-to-face TVI as a reference standard for the virtual DTVI groups. Since the same tutor is assigned both a TVI and a DTVI group, both the course content (the videotaped lecture) and facilitator are held constant across TVI and DTVI conditions. Assuming that individual learning differences are randomly distributed across the TVI and DTVI groups, differences in the DTVI groups' patterns of interaction will point to ways in which the DTVI interface changed the nature of collaborative learning. We begin our analysis with a

quantitative comparison of speech acts. Then we will look separately at content and relational discourse.

General Discourse Patterns

Previously, we have defined discourse to include both verbal and non-verbal behavior. In this section, we focus only on verbal discourse. In the table below, we compare a number of quantitative dimensions of discourse. These counts were derived by the group facilitators from videotapes of the group interaction taken approximately three weeks apart for the length of the term. The final logging database contained information on over 3500 exchanges spanning 328 course sessions for 70 groups (448 students). The table below summarizes the logging data. Items where a t-test showed that TVI and DTVI differed significantly at the .05 level are highlighted using bold, italicized text.

Logging Data	TVI mean	DTVI mean	p-value
Avg. Number of Exchanges	10.61	10.91	.678
Avg. Duration of an Exchange	78.5 sec	82.5 sec	.318
Avg. Total Turns per Exchange	***14.46***	***16.23***	***.005***
Avg. Student Questions per Exchange	2.32	2.54	.063
Avg. Student Statements per Exchange	6.48	7.04	.071
Avg. Tutor Questions per Exchange	***1.84***	***2.43***	***.000***
Avg. Tutor Statements per Exchange	***3.81***	***4.19***	***.020***
Avg. Percent of Group Members Participating in an Exchange	51.6	51.9	.680
Avg. Percent of Exchanges Flagged as Containing Humor	***12%***	***16%***	***.001***

We defined an exchange as a sequence of four or more conversational turns around the same topic (regardless of whether the tutor paused the video lecture). Each conversational turn within an exchange was further characterized as a tutor question, tutor statement, student question, or student statement. TVI and DTVI sessions usually lasted from one to one-and-a-half hours, depending on the course. Both TVI and DTVI groups averaged just under eleven exchanges in a typical session. Average duration for an exchange was between one and one-and-a-half minutes. A typical exchange included roughly fifteen distinct conversational turns.

The quantitative discourse pattern is quite similar for TVI and DTVI groups. There was not a statistically significant difference in average number of exchanges or average duration. However, DTVI students tended to have more changes of turn within each exchange. In particular, the tutor was more active in DTVI sessions. We found a statistically significant increase in both tutor questions and tutor statements in DTVI groups. While these statistics don't show the DTVI groups having significantly more frequent or longer conversations, the increase in conversational

turns, combined with a subjective analysis from watching videotapes of sessions, leads us to characterize the DTVI groups as slightly "chattier."[10]

In general, more interaction among participants in a collaborative learning group would be beneficial for learning, both because of the potential for additional content-related discussion and because it engenders (and is evidence of) good group cohesion. There are three obvious exceptions:

1. If the increased discourse is a result of disagreements that go beyond content issues and negatively affect group cohesion;
2. If the discourse is mostly off-topic and therefore detracts from the time and effort devoted to learning; and
3. If the increased discourse results from working around communication breakdowns resulting from the DTVI interface.

These first two possibilities will be discussed more thoroughly in the sections below on content and relational discourse. As for the third possibility, we found no evidence of significant communication breakdowns in the DTVI condition. Students reported no problems with turn taking or other aspects of communication. Furthermore, had communication breakdowns been a problem, we might expect to see differences between TVI and DTVI in the average percentage of group members participating in exchanges. We did not find such a difference. In fact, to the extent that humor relies on timing and other subtle communication cues, the finding that DTVI groups used more humor is additional evidence of the ease of communication in DTVI.

Content-Oriented Discourse

In looking at content-oriented discourse, we will employ three different kinds of evidence. First we will look at quantitative patterns of verbal discourse. Then we will look at subjective tutor ratings of the content quality of TVI and DTVI exchanges. Finally, we will examine student survey responses that relate to content discourse.

Recall that tutors rated each videotaped exchange for the quality of content in the exchange. The ratings are on a –2 to +2 scale. Since we don't have a direct indicator for whether an exchange was content-related, we filtered the data to look only at exchanges to which tutors assigned a positive content rating. To be rated as "+1," an exchange has to include content information that goes beyond an ordinary exchange. To be rated as "+2," the quality of the content must be exemplary. In both cases, we can be assured that the exchange had a strong content component. We excluded all other exchanges because the neutral (0) and negative ratings are ambiguous with regard to how much of the exchange was content-oriented and how much may have

[10] It is important to note that many of the collaborative learning groups in this experiment had more restrictive time constraints than in prior TVI research [Gibbons, Kincheloe, and Down 1977]. The limited discussion time created a ceiling on the frequency and duration of exchanges. Even if DTVI groups were inclined toward more discourse (as opposed to more interaction within each exchange), the time limitation would have made this difficult. Given the pattern in the data, we believe that with a less restrictive time constraint, DTVI students might have had more frequent and longer exchanges than TVI students.

been off-topic. So while our sample may not include all content-oriented exchanges, we can at least be sure that all exchanges included are content-related. A sampling of the findings from this subset of the data is presented in the table below.

Logging Data	TVI mean	DTVI mean	p-value
Avg. Duration of an Exchange	105.9 sec	101.5 sec	.488
Avg. Total Turns per Exchange	18.09	18.24	.887
Avg. Student Questions per Exchange	2.96	3.00	.833
Avg. Student Statements per Exchange	7.72	7.40	.505
Avg. Tutor Questions per Exchange	***2.52***	***3.16***	***.001***
Avg. Tutor Statements per Exchange	4.87	4.63	.408
Avg. Percent of Group Members Participating in an Exchange	56.24	56.62	.781

When we limit the analysis to content-oriented exchanges, the overall pattern of more interaction in DTVI groups disappears. Only one item—the increase in tutor questions in DTVI groups—turns out to be statistically significant for positive content exchanges. Furthermore, looking at the differences in means that did not achieve statistical significance, we no longer see the clear pattern of more interaction in DTVI. It appears that—with the exception of increased tutor questions—the increased interaction in DTVI sessions falls largely outside the content domain.

To this point, we have looked only at the quantity of content discourse. But there is also a quality dimension to content. For instance, highly involved discussions or conversations that entail intellectual controversies may have more learning value than simple explanations or statements of fact. Even if DTVI doesn't inhibit the number of conversations, it could conceivably affect the ability of students to have these intellectually rich types of discussions. To find out whether this is the case, we looked at the means of the tutor ratings of exchange content quality. Since tutors are the available subject matter experts for the course, they should be in a good position to judge the extent to which a discussion has content value.

Logging Data	TVI mean	DTVI mean	p-value
Avg. Content Rating	.35	.35	.917

Again, the news is good for DTVI. We found no difference between the mean content ratings for TVI and DTVI exchanges. We also asked students about the value of their peers' discourse in helping them understand the material:

Question	TVI n	DTVI n	TVI Mean	DTVI Mean	P-Value
How much did your group assist you in getting the grade that you wanted? [1 = not much, 7 = a great deal] (EQ3 42)	37	39	4.92	4.74	.563
Typically we resolved problems of understanding the material in the class sessions. [1 = disagree, 7 = agree] (EQ1 20)	135	118	5.73	5.59	.375
Hearing my peers' questions helped my own understanding of the topic. [1 = disagree, 7 = agree] (EQ3 17)	38	39	6.08	5.72	.200

There were no statistically significant differences in the answers to these questions either, although the means for TVI groups were slightly higher in all three cases.

Considering all of the evidence, we conclude that content-related discourse was very similar for TVI and DTVI groups. Since content is carried primarily in the audio channel, and the audio channel is the least likely to be disrupted by the DTVI system, this finding is not entirely surprising. We will now turn our attention to the relational domain to see if DTVI can also support the largely non-verbal communication needed to build and maintain group cohesion.

Relational Discourse

The bonding of individuals together into a group is the core mechanism that drives the proactive interaction that produces the collaborative learning effect. Following Bales (1953), we will call this felt sense of connection to one's fellow group members *group cohesion*. Groups with high cohesion enjoy working together. As a result, members are more willing to place the overall benefit of the group ahead of their own individual desires. In their review of collaborative learning, Johnson and Johnson (1996) list the positive effects of this relational dimension of collaborative learning:

> *Generally, the more positive the relationships among group members, the lower the absenteeism, the fewer the members who drop out of the group, and the more likely students will commit effort to achieve educational goals, feel personal responsibility for learning, take on difficult tasks, be motivated to learn, persist in working toward goal achievement, have high morale, be willing to endure pain and frustration on behalf of learning, listen to and be influenced by classmates and teachers, commit to each other's learning and success, and achieve and produce. p. 1024*

The role of relational discourse in learning is more complex than that of content-related discourse. First, relational discourse on its own does not guarantee good learning results. Therefore, quantitative measures of relational discourse are somewhat hard to interpret with regard to their impact on learning. In the absence of content, relational discourse takes the form of "BS," or friendly chatting. Not only does this type of discourse not necessarily foster learning, it can actually detract from it if it diverts time and attention from instructional content. In that sense, relational discourse is more a catalyst than a producer of learning. Second, relational discourse

both engenders group cohesion and is a product of it. It is self-reinforcing. A discursive act that improves group cohesion will bring about more such acts. Therefore, when we examine evidence of relational discourse, it is sometimes difficult to know whether to think of it as a cause or an effect.

We have already established that the slight increase in interaction (conversational turns) in DTVI groups is largely outside the content domain. Since most non-content-oriented discussion serves to increase the social bonds among group members, it would seem that increased relational interaction might correspond with increases in group cohesion for DTVI students. On the other hand, most of the disadvantages of virtual communication also lie squarely in the relational domain, particularly the diminished capacity for non-verbal communication. Hence, we might also logically predict that group cohesion would be more problematic for DTVI students. To find out, we will look first at tutor ratings of the relational value of exchanges. Then we will examine student survey items that ask students directly how connected they felt to their group. Finally, we will look at indirect products of group cohesion: for example, the willingness of students to ask questions or admit they don't know something.

The tutor ratings for the relational value of an exchange use the same scale as the content ratings. A negative rating implies that an exchange hurt group cohesion; a positive rating indicates that it helped. A neutral rating means that the exchange was typical and had no particular impact on group cohesion. The mean ratings for TVI and DTVI groups are presented below.

Logging Data	TVI mean	DTVI mean	p-value
Avg. Group Rating	.36	.38	.457

As with the content rating, we find no statistically significant difference between tutor ratings of relational discourse. To the extent that this measure is an accurate gauge of group cohesion, whatever increase in relational interaction DTVI groups had either did not lead to qualitative increases in group cohesion or was counterbalanced by other factors. To explore the issue further, we also asked students directly about group cohesion:

Question	TVI n	DTVI n	TVI Mean	DTVI Mean	P-Value
Did you feel that what you said today was valued by your peers ? [(1) less - (7) more] (SQ2 3)	124	107	3.94	3.78	.573
Relative to your typical classmates, how "connected" do you feel towards the other members of your group? [(1) distant - (7) close] (SQ2 3)	224	205	5.23	5.24	.919
How comfortable were you with the other group members? [(1) not much - (7) a great deal] (EQ3 41)	37	39	5.95	5.56	.255

Again, we do not see any statistically significant differences between TVI and DTVI groups. Both conditions gave high marks to their group experience.

Finally, we turn to indirect measures of group cohesion. That is, we asked students about behavior that we would expect to be connected to their feelings toward their group. In particular, we asked about ease of asking questions. Asking a question,

particularly a question that signals to others one's misunderstanding of the lecture content, may diminish the status of the asker in the eyes of peers. In social settings, where questioning has this social stigma, questioning behavior will diminish over time. On the other hand, social settings in which questioning is supported and welcomed will encourage questioning. Encouraging questioning behavior of this type involves creating a supportive group climate in which risks of "losing face" are minimized. Maintaining that climate will involve using the nonverbal discourse channel to convey continued interest and genuine concern for the intellectual progress of the group members. Most of this work is performed by the mutual attending behavior that accompanies discourse. Any disruption of this relational information caused by interacting through the DTVI interface—for example reduced visual presence and the lack of direct eye contact—could adversely affect the climate of mutual regard necessary to support questioning behavior. If so, then participants would experience questioning as more difficult in DTVI than in TVI.

We will focus on two items related to questioning—one focusing on actual number of questions asked, and the second on the ease of asking questions.

Question	TVI n	DTVI n	TVI Mean	DTVI Mean	P-Value
I asked more questions than usual for me. [(1) disagree - (7) agree] (EQ3 16)	38	39	5.53	4.38	.007
How easy was it for you to ask questions you were not sure about what was being said? [(1) difficult - (7) easy] (EQ3 46)	17	18	6.04	4.89	.051

Here we find our first solid evidence that there may be process differences between TVI and DTVI. TVI students reported asking more questions and also reported that asking questions was easier. Note that "4" is the midpoint on the scale. We can think of this as representing typical behavior. So at just above 4 on the scale, DTVI students felt only a slight advantage to the virtual collaborative learning environment when it comes to question asking. By contrast, the TVI ratings were close to six on the seven-point scale. Clearly, the DTVI interface did have some negative impact on self-reported questioning behavior.

It is interesting to note the contrast between student reports and actual quantitative analysis of questioning behavior. TVI students reported asking more questions than DTVI students. But, in fact, DTVI students actually had a higher mean for student questions overall (although the difference was statistically significant only at the .10 level). For content exchanges, the student question means for TVI and DTVI groups were statistically indistinguishable. The fact that DTVI had a negative impact on perceptions, but not on actual behavior, begins to hint at the nature of the effect of virtual communication on collaborative learning. As will be discussed in Part 4 of this report, we believe this may be explained by a distortion in mutual attending behavior resulting from the DTVI interface.

Correlations between Discourse and Learning

Before we leave the topic of discourse, we will take the opportunity to test the theoretical connection between discourse and learning. We ran partial correlations

between indicators of content-related discourse and grade (controlling for GPA). We then repeated the process for group-related discourse.

To assess the contribution of content-related discourse, we started with the –2 to +2 content ratings assigned to exchanges. Surprisingly, correlation between high average content ratings for groups and student learning was significant only at the .10 level (r=.086, p=.086). When we looked at the percentage of all exchanges that had positive content ratings, we found a modest correlation (r=.11, p=.023). However, we did not find the expected corresponding negative correlation with percentages of exchanges that had negative ratings. Nor did we find a significant correlation with the average number of content-oriented exchanges per session. A longer average duration for positive content exchanges did show a small positive correlation with learning (r=.10, p=.038).

Somewhat surprised by the weak relationship between learning and direct measures of content-oriented discourse, we looked in the student survey data for items suggesting high content value for exchanges. Here the correlation results were mixed. For instance, we saw no correlation with learning for these survey items:

- *How knowledgeable on the course content would you rate the facilitator?*
- *How well prepared were your fellow students for class?*
- *The questions I asked in class were adequately answered.*
- *Overall, how informative was your peers' discussion of the lecture material?*
- *Rate the group's ability to answer your questions.*

But we did see a correlation with the questions

- *The facilitators added a lot to my understanding of the course material.*
- *Typically, we resolved problems of understanding the material in class sessions.*

Overall, we have to conclude that content-oriented discourse showed a relatively weak relationship with learning. Where there was a relationship, the value of content-oriented discourse seemed to be more in the use of discourse for knowledge construction activities rather than the exchange of content information per se. For instance, the questions that referred specifically to content contributions or previous knowledge of participants did not correlate with learning. The last two questions, which did correlate with learning, suggest facilitator and students working together as a group to construct knowledge. Longer exchanges, which also correlated with learning, may be another indicator of knowledge construction.

For relational discourse, the story was different. We found a positive correlation between our +2 to –2 group cohesion ratings and learning (r=.12, p=.015). We also found that percentage of exchanges with positive group cohesion ratings had a positive correlation with learning (r=.15, p=.003). Unlike content ratings, percentage of exchanges with negative group cohesion ratings had the expected negative correlation with learning (r=-.13, p=.009).

When we looked at student survey items that related to group cohesion, the strong positive pattern continued. All of these questions showed a positive correlation with learning:

- *How connected do you feel toward the other members of your group?*
- *Did you feel that what you said today was valued by your peers?*
- *Did you find yourself talking less, the same, or more than you normally do with your peers?*
- *Is it easier or harder than normal to ask your group for assistance with course material?*
- *I found it easy to participate in class discussions.*
- *Everyone usually participated in our group discussions.*

For both content-oriented and relational discourse, there was some evidence of the expected correlation with learning. But, the correlation between relational discourse and learning was noticeably stronger than the correlation between content discourse and learning. While we acknowledge that correlation does not imply causality, our findings do suggest that the ability to support relational discourse may be a crucial issue for collaborative distance learning technologies.

Discourse Summary

Discourse is at the heart of the collaborative learning effect. Based on the evidence we have presented so far, there is little reason to believe that the virtual DTVI interface has much impact on discourse patterns compared to face-to-face TVI. In fact, we would have to characterize the similarities between the two conditions as remarkable, particularly in light of previous research showing that virtual communication can be problematic. Even with a huge sample of exchanges to maximize the sensitivity of statistical tests, we could only detect minor differences in quantitative discourse patterns. The pattern in overall discourse amounts to a slight increase in interaction within exchanges, but no significant increase in frequency or duration of exchanges. The evidence for content-related discourse shows hardly any differences at all. In the relational domain, we see only a slight difference in perceptions of questioning behavior between TVI and DTVI students.

All in all, we conclude that the virtual DTVI interface does an excellent job in preserving the collaborative learning effect—at least with respect to easily observable discourse phenomena. But the differences in perception between TVI and DTVI students, while subtle, point to a more complex picture of collaborative distance learning. In the next section, we will paint a richer, more detailed picture of the impact of the DTVI interface on collaborative learning.

Part 4: Analysis

Exploring the Effects of the DTVI Interface on Collaborative Distance Learning

The Proximal-Distal Engagement Continuum

One of the most salient aspects of interacting through the DTVI interface is how far removed one is visually from the action. Everything is remote to the learner—the instructor, facilitator, and peers are all projected at reduced size on a flat computer display. It is our conjecture that these smaller, televised images of course resources produce a subtle, yet tangible reduction in the perceived importance and value of these resources. This reduction in salience produces a corresponding reduction in engagement. The intuition that a phenomenon becomes less engaging as the perceived distance increases is hardly new. Simply consider the price differential between front row seats and the seats at the back of an auditorium. We will call this lessening of engagement as a function of increased experienced distance from a phenomenon *distal disengagement*.

We envision a spatial continuum in which increased experiential proximity to a phenomenon leads to greater levels of engagement at one end, while decreased experiential proximity leads to distal disengagement on the other end. Prior work on the territoriality of animals and humans [Sommer 1959; Schefflen 1970] indicates that species maintain spatial zones around themselves. Within these zones, certain types of behavior are permitted while others are rejected by invoking compensatory behavior towards the intruder. For instance, if someone intrudes into a person's personal space, the person intruded upon is likely to reduce eye contact [Patterson 1977]. Similarly, as the physical distance decreases between a person and an intruder, the person intruded upon is likely to change their body orientation side-ways to lesson the experienced impact of the intrusion [Sawitsky and Watson 1975]. In both these examples, people redirect their attentional resources away from an intruder to reestablish a comfortable level of engagement relative to their physical proximity to the stimulus. While both of these examples involve violations to participants' sense of the appropriate level of engagement, it is equally likely that people move closer to phenomenon when they want to increase their engagement.

The DTVI interface provides minimal support for changing visual proximity to learning resources. Students can enlarge the cell of a single peer to fill the entire window, but at the cost of losing the view of everyone else. Or they can ask a peer to bring their face closer to the camera so that it fills the video frame. Getting more distal involves leaning back from the computer monitor and camera. In general though, the small size of the broadcast images creates the visual impression of being fairly distal to the displayed learning images. Prior work by Patterson (1968) has shown that initial impressions of a person can be influenced by the observer's proximity to them. Patterson found that subjects rated the same person as warmer and more likeable when the stranger was more physically proximal to the subjects

than when the stranger was more distal. It is our conjecture that participants in the DTVI condition have to overcome a similar attribution process at the beginning of the term. Assisting them in this process is the open microphone architecture with its minimal lag time, which closely approximates the aural environment of real-time, face-to-face interaction. To the extent that the information required for engagement decisions with peers is encoded across both the audio and visual channels during discourse, then the visual effects of distal disengagement are moderated by the aural proximity of peer discourse.

Another potential source of reduced engagement for DTVI participants stems from the fact that, regardless of the size of the visual image, the visual resources for the course are all televised. Students' prior experience with television will have given them expectations about the nature of televised images. These expectations will inform the initial experience of the participants in the DTVI condition. Because participants' predominant television experience is likely to be one-way broadcast, there is little to prepare them for interacting with a televised image that responds to them. In a series of studies on attitudes towards different media, Salomon (1983) found that participants perceived television as being less demanding than the equivalent content in print form. Participants in Salomon's research also reported that they exerted less mental effort while viewing television. If these attitudes about television are true for our participants, then their initial expectations about prior televised images may lower their level of engagement with all the televised learning resources.

A shortcoming of this cited prior work on attitude formation is that it describes only the results of the initial impression formation process. In the case of attitudes towards televised images, there has been no contradictory experience that would undermine participants' belief in the passive nature of watching a televised image. Fundamental to all learning theories is the assumption that beliefs can be changed through experience. The DTVI process actively fights the passive television mind set by having the tutor periodically stop the tape and invite discussion. While viewing the video of the course lecture may recall familiar viewing habits, the discussion at pauses in the video involves interacting with televised images of peers in a novel way. So DTVI participants may begin the term less engaged than their face-to-face counterparts in TVI, but may overcome their initial high level of distal disengagement as they actually interact with the televised images. Through this process, peers will be increasingly identified as useful learning resources. This will increase the salience of peers, which may in turn modify the initial distal impressions of the group members. Storck and Sproull (1995) found that saliency, in the form of more access to information on a collaborator, lead to higher ratings on desire to work with that person again. In addition, there is a large literature on how saliency, in the sense of information that is readily available (e.g. the availability heuristic), can influence judgments under uncertainty [Tversky and Kaneman (1982)].

We will assume that degree of experienced proximity to a phenomenon is influenced by many factors besides the few we have mentioned here. In the present field study, we won't be able to differentiate them. We will instead attempt to document the breadth of this phenomenon by comparing how TVI and DTVI students rate a number of the activities involved in collaborative learning. For instance, we have previously documented that DTVI users rate their enjoyment slightly lower than TVI students and also that they report somewhat lower amounts of question asking. Could these differences be the result of distal disengagement?

The clearest manifestation of distal disengagement occurs in the contrast between the TVI and DTVI students ratings of their course instructor and their facilitator. These two sources of expertise are the primary content resources that are available to both TVI and DTVI students. Because they are shared across groups, they provide the only opportunities to rate the same object across conditions. The only contact TVI and DTVI students have with the instructor is through the videotapes of the course lectures. In contrast, the TVI students experience the facilitator face-to-face, while the DTVI students experience the facilitator through a small video portal. Bear in mind that we have controlled for facilitator effects by having each facilitator run both a TVI group and a DTVI group each term. Hence TVI and DTVI students are rating the same set of facilitators. The proximal-distal relationship for the course instructor and the facilitator is given below.

	TVI	DTVI	Lecture
Lecturer	Distal	Distal	Proximal
Facilitator	Proximal	Distal	Proximal

We begin our comparison by considering students' ratings of their instructor. The ratings use the familiar 7-point Likert scale:

Question	TVI n	DTVI n	TVI Mean	DTVI Mean	P-Value
How would your rate your professor as an instructor? [1 = not much – 7 = a great deal] (EQ3 38)	37	39	5.41	5.64	.430

There is no significant difference between TVI and DTVI groups on this rating of the instructor, who has the same proximity for both TVI and DTVI students. Compare this result to the following question about the facilitator:

Question	TVI n	DTVI n	TVI Mean	DTVI Mean	P-Value
How knowledgeable on the course content would you rate the facilitator? [poor – excellent] [SQ1]	224	205	6.15	5.97	.009

TVI students rate their facilitators significantly higher on content knowledge than do DTVI students. These findings are similar to previous research in which students who interacted face-to-face with some students and through a video conferencing system with other students formed more positive impressions of the competencies of their face-to-face peers than their remote counterparts [Storck and Sproull (1995)]. Since both conditions are rating the same tutors, the only way that TVI tutors could reflect additional acumen with the content was if we had scheduled TVI sections after DTVI sections. In that case, there might have been a practice effect in which the facilitators' second performance on the same lecture content was more polished than the first. But we controlled for practice effects by counterbalancing facilitator sequence across the TVI and DTVI conditions. The contrast between facilitator ratings provides clear evidence for the distal disengagement effect.

How general is this distal effect? We have shown that content knowledge is susceptible to a lower rating. Since the facilitator's main responsibility is to encourage proactive interaction in the group, we also asked students about the tutor's facilitative skill.

Question	TVI n	DTVI n	TVI Mean	DTVI Mean	P-Value
How responsive to the students learning needs was the facilitator? [poor – excellent] [SQ5]	224	205	6.04	6.03	.843

This result fails to support the most general form of lowered ratings as a function of distal disengagement. Distal disengagement seems to apply to facilitators in the content domain, but not in the area of facilitative skills.

Our leading candidate to explain this discrepancy is that saliency through frequent interaction with a remote resource mitigates the effects of distal disengagement. That is, distal disengagement, much like gravity, is always operating in the DTVI condition. However, a sufficiently large number of remote transactions with a resource can increase the functional saliency of that resource and thereby overcome the initial effects of distal disengagement. During their training as TVI tutors, facilitators were discouraged from answering student questions directly. The goal was instead to foster student discussion. So if the tutors are doing their job, the bulk of their transactions with group members will be in the area of facilitation rather than content. So the value of students' transactions with the facilitator in the content domain would be relatively low—hence, the lower rating of facilitators' content knowledge by the DTVI participants. If true, this interpretation is a ringing endorsement for the power of social interaction to overcome the inherent distal disengagement associated with all forms of remote learning.

Our next exhibit on the pervasive nature of distal disengagement is a three-way comparison between lecture, TVI, and DTVI on how challenging students found the course content (higher scores meaning more difficult). This comparison reflects increasing distance from the course content. The lecture students are in the room where the lecture is being given. The TVI students are distal to those exchanges but are proximal to peer discussion of the content. The DTVI students are distal to both the lecture and the peer discussion of the lecture. A test of between-subjects effects shows that differences in means were significant (p=.006). Ratings of course difficulty preserve the ordered proximal relationships between the content source and the observer across the three conditions. As students became more distal to the source of the content, they rated the course content less difficult. It seems unlikely that DTVI students have additional unidentified intellectual resources that make the content easier. If, however, the degree of distalness is related to degree of disengagement, and disengaged participants find activities less challenging than engaged participants, then the DTVI students' experience would make sense.

Descriptive Statistics for Perceived Course Difficulty (COURSEDIF)

METHOD	MEAN	Standard Deviation	N
Lecture	4.43	1.04	148
TVI	4.37	1.04	99
DTVI	3.93	1.57	92
Total	4.28	1.22	339

Tests of Between-Subject Effects

Dependent Variable: Perceived Course Difficulty (CORSEDIF)

SOURCE	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	15.0 *	2	7.49	5.14	.006
Intercept	5848	1	5848	4019	.000
METHCODE (Lecture/DTVI/TVI)	15.0	2	7.5	5.14	.006
Error	489	336	1.5		
Total	6706	339			
Corrected Total	504	338			

* R Squared = .030 (Adjusted R Squared = .024)

Our premise all along has been that interacting through the DTVI interface might alter a participant's interaction. We posited three potential sources for distorting interaction. Our first source, problems in coordinating turn taking due to network transmission artifacts, was not supported by user ratings on the ease of jumping into an ongoing conversation. We were able to minimize this problem by creating a network with no perceptible latency. Our second source of potential problems, distal disengagement, is caused by the subjective sense of being removed from the source of activity. We demonstrated that viewing the lecture and fellow participants through a small video window leads to less engagement with the course content than would have occurred in face-to-face settings. We now turn to investigate our third potential problem: participants' signaling of mutual attending during group discourse. This problem stems from the fact that the approximately 8-inch spatial differential between the camera and the facial array on the computer monitor makes eye contact difficult and gaze directional cues ambiguous.

Distortions in Mutual Attending

Mutual attending is the continual nonverbal signaling of how participants of a conversation are allocating their attentional resources. Eye contact, affirmative head nodding, and re-orienting one's body and gaze towards a new speaker are all examples of how proactive interaction is encouraged on a moment-to-moment basis. For example, consider a TVI group listening to conversants sitting at either end of the table. The participants in the middle swing their heads back and forth at each conversational turn, much like a tennis match. These public attending behaviors serve to signal each member's current attentional focus. Stare off into space too long

and someone will ask you if you are alright. That is because there is a reciprocal covenant to contribute to conversations in order to move them forward. The minimum contribution of listeners is to signal that their attention is directed to the speaker. In comparisons of video-mediated and audio-only conversations during problem-solving, Anderson et. al. (1997) found that mutual attending behavior was used by speakers to judge how successfully they were communicating. They found that by using this back-channel, listeners needed to interrupt speakers less often to get feedback than in the audio-only condition. They also found that mutual attending behavior established a sense of co-presence that made subsequent collaborative behavior easier.

The DTVI interface doesn't support direct eye contact. Nor does the array of virtual windows support spatial adjacency relationships between people. It is our conjecture that DTVI's less than complete support for non-verbal mutual attending behavior adversely effects the relational dimension of peer interaction. We posit that the reduction in the ability to track the real-time mutual attending behavior of peers leads to a relaxation in the reciprocity covenant. This will result in lower levels of support for proactive discourse. Referring back to the user satisfaction questions, recall that TVI students rated their group experience as significantly more enjoyable than their DTVI counterparts. If it is true that the reciprocity covenant is relaxed under DTVI, speakers in DTVI sessions receive less public acknowledgement for their discursive contributions. This may be an important factor in the lower enjoyment ratings. It may also contribute to the differences in self-reported questioning behavior discussed in the previous section on relational discourse. If a question does not receive the non-verbal acknowledgement that we are used to, the questioning behavior may feel less salient, which might show up as a perception that fewer questions were asked.

Since these effects are quite subtle, we will switch our questioning strategy. Until now, we have been using comparisons of Likert scale items to assess the experience of interaction in TVI and DTVI. The assumption is that both types of groups face the same array of issues with the same array of resources. Ideally, one would like to expose each participant to both conditions and then ask what difference there is between TVI and DTVI. But prior research has shown that moving subjects from a face-to-face condition to a distance learning condition purely for the purposes of the experiment leads to artificially low ratings of user satisfaction compared to participants who receive only the distance learning condition [Beare (1989)]. Since our field experiment was conducted on students taking university courses, it would also be unethical to place students at a potential disadvantage by altering the conditions during the term.

To work around this constraint, we gave a questionnaire to the DTVI students at the end of the term. With 10 to 14 weeks of experience interacting through the DTVI interface, these students were the resident experts. We assumed that their prior experience with face-to-face interaction provided them with many reference points to make comparisons between the two conditions. In this questionnaire, each question is phrased as a hypothetical intention that one might want to realize in a group setting. Participants were asked to select which group context—face-to-face or DTVI—would make realizing that intention easier. To avoid making the forced choice overly artificial, we also allowed them to select “no difference” if they felt the two conditions were equivalent. Using their preferences for each hypothetical situation, we can more directly assess the subjective experience of interacting

through the DTVI interface. Results are reported as the percentage of participants who choose a given category.

For example, we asked DTVI students about eye contact:

Question	n	Face-to-Face	DTVI	No Difference
11) If you wanted to make eye contact with one of your classmates, which setting would make it easier?	160	89%	5%	6%

Eye contact is a potentially powerful form of non-verbal communication. It is critical to the expression of sincerity and the negotiation of trust. Eye contact is a specific instance of a larger set of social cues used by participants to infer the attentional focus of their peers. Speakers use the direction of their audience's eye gaze as feedback as to whether or not they currently have their audience's attention. As the responses to the above item show, almost ninety percent of the participants felt that DTVI made eye contact difficult relative to the face-to-face interaction that characterizes TVI.

For a more general case of signaling attentional focus through gaze, we asked about a particular social situation—staring at someone else. People stare for a variety of reasons. In the simplest case, they may be waiting to gain the attention of the watched person when their eyes meet. At the other extreme, someone might be obsessed with another person. Because of the communicative power of eye contact, it is considered impolite to stare at someone for long periods of time. People detect staring by noticing the direction and duration of someone's gaze. The inability to detect the direction of gaze should make it very easy for DTVI participants to watch someone without that person noticing. Consider the responses to the following question:

Question	n	Face-to-Face	DTVI	No Difference
3) If you wanted to watch someone in your class without being noticed by them, which setting would be easier?	160	1%	88%	11%

While staring is a particularly glaring example of the communicative value of gaze, it is indicative of a whole range of communicative behaviors that signal to others a participant's attentional focus. In a fundamental sense, looking at the same object as one's cohorts is a way of displaying one's affiliation with the current attentional focus of the group. Further, if one is confused about what is going on in a group situation, following the direction of people's gaze is an unobtrusive way to begin orienting behavior. To illustrate the difficulty of determining the attentional focus of a DTVI group based on the direction of their gaze and body orientation, consider the picture below. It appears as though one subgroup is looking left, while another subgroup is looking right. While it would be natural to assume that each subgroup was looking at a different object, in reality, they are all watching the video of the lecturer who is standing in the lower right frame. The appearance of divided focus is an artifact of the camera's being placed on the left or right side of the computer monitor.

We posited that the inability to make eye contact would make it more difficult for peers to signal mutual attending to each other non-verbally. One of the most important streams of information that is communicated over this channel is ongoing facial reactions of the listener to what the speaker is saying. Consider the responses to the following question:

Question	n	Face-to-Face	DTVI	No Difference
If you said something to the group and wanted to get a quick sense of whether they agreed or disagreed with you, which setting would make reading your peers' expressions easier? (NL 14)	160	44%	22%	34%

For the two-thirds of the respondents that rated a difference, there is a two-to-one margin in favor of face-to-face settings for reading facial expressions in order to gauge the reaction of the group. As expected, DTVI students experience their groups' nonverbal reactions to what they say with greater ambiguity than their face-to-face counterparts. This element of “noise” in the non-verbal, relational channel may dampen slightly the promotive interaction necessary for building the collaborative learning effect.

Complicating this interpretation is the fact that the small screen size, peer's distance from the camera, and prior attitudes towards viewing televised images may also contribute to the difficulty in "reading peers' expressions" that the DTVI users report. It is beyond the scope of this experiment to analyze the respective contributions of each of these sources of distal disengagement. Here, our aim is only to add ambiguities in mutual attending behavior to the list of issues DTVI users encountered. Regardless of the source, it seems fair to characterize the DTVI environment as having less social presence than its TVI counterparts. How might this "reduced social presence" impact the discursive dynamics required to develop and maintain a working group?

The Impact of Reduced Social Presence on Reciprocity

As a form of rational social action, conversational participants are expected to contribute to the success of the discourse [Grice 1975; Levinson 1983]. From our perspective, the minimum participant commitment is to display orienting behavior to the ongoing conversation. Obviously, adherence to these conversational maxims is central to achieving the proactive discourse that fuels the collaborative learning effect. As we have pointed out previously, the DTVI interface interferes with a subset of the non-verbal attending cues that a speaker can use to interpret the attentional focus of his audience. For instance, in an earlier Sun research report on distance learning using the prototype Forum video conferencing system, the instructor's chief complaint was that he couldn't see his audience as he lectured to gauge the effects of his lecture [Isaacs, Morris, Rodrigues, & Tang 1995; Pannoni, Buckley & Gibbons 1993]. Without real-time visual feedback, the lecturer had no basis for adapting his moment-to-moment delivery of the content to the students.

We have established that the DTVI interface makes it more difficult for a speaker to read the audience. This also makes it harder for each speaker to detect whether the audience is actually holding up their end of the attentional covenant. This relaxing of the moment-to-moment social contract between speaker and audience potentially allows participants in DTVI to engage in a range of behaviors that would be considered rude in a face-to-face context. For example, it is usually considered impolite to perform work of an unrelated nature during an ongoing, face-to-face conversation. If, however, the "noise" in the ongoing monitoring of participant attentional focus made it less likely that participants' would be caught violating their attentional covenants, then it should be less risky to violate the covenant.

Question	n	Face-to-Face	DTVI	No Difference
If you wanted to work on something else during a slow part of the taped lecture, which setting would make it easier to get some other work done? (NLQ 1)	160	7%	86%	7%
If you found the lecture boring, and were looking for some kind of stimulation to keep you awake, but you didn't want to disturb others, which setting would be more entertaining? (NLQ 10)	160	7%	84%	9%

Here we do see strong evidence of this effect. The viewing field of the cameras does not extend to the desktop in the individual cubicles, so other participants wouldn't be able to see an object that a group member was looking at. This would not be the case in the equivalent face-to-face situation. As the risk of getting caught diminishes, students may extend the relaxation of the attentional covenant to a variety of previously "impolite" behaviors. Eating in front of others is another interesting case. The basic assumption of Grice's conversational maxim is that everyone contributes. If a member has food as a resource, should the expectation to make a contribution extend to sharing one's food? Or said another way, is it polite to eat in front of others, without offering them food?

Question	n	Face-to-Face	DTVI	No Difference
6) If you wanted to eat a snack during the lecture, which setting would make it easier?	160	5%	66%	29%

Unlike the surreptitious reading of a book laid flat on the counter out of the camera's visual field, eating involves bringing food through the visual field to one's mouth in plain sight of peers. So DTVI students' willingness to openly eat in front of others is even stronger evidence of the weakening of the social covenant.

We have now pointed out two examples of the effect of reduced social presence in the DTVI environment. If this effect is broad in scope, it could be problematic for collaborative learning. Among the potential barriers to group effectiveness that Johnson and Johnson (1994) list are social loafing (hiding in the crowd) and free riding (getting something for nothing). It is easy to see how the DTVI interface would encourage both of these behaviors. Consider the case of social loafing:

Question	n	Face-to-Face	DTVI	No Difference
8) If you felt slightly out-of-it, and didn't want to interact with anybody, which setting would make it easier to lay low?	160	6%	80%	14%
13) If you weren't prepared for class, and you didn't want to be called on, which setting would make it easier?	160	8%	59%	33%

The potential for weakened collaborative behavior in a virtual environment is evident from these question results.

Up to this point, we have been exploring a variety of situations in which the relaxation of the mutual contribution covenant would make it easier for a DTVI participant to invest less in their collaborative learning group while remaining a member in good standing. While decreased social presence may have a deleterious effect on collaborative learning, it may also present advantages for individual participants. In previous research on the Forum system [Isaacs, Morris, Rodrigues, & Tang 1995; Pannoni, Buckley & Gibbons 1993], users working at their own cubicles actually cited as an advantage the ability to temporarily disengage from the group and handle other business without being detected. Of course, in the Forum study, the tradeoff was less severe because the instructional model was broadcast-oriented (i.e., based mainly on one-way information flow from lecturer to student). Learning was not tied to the strong sense of group participation that underlies a collaborative learning approach.

While promoting more individual freedom from the demands of group participation, this "noise" in the real-time signaling of mutual attending may also serve as a filter. It may dampen the expression of genuine positive regard and enthusiasm for what a group member is saying. This would cause students to experience each other as more emotional distant. Consider the following:

Question	n	Face-to-Face	DTVI	No Difference
18) If you were exhausted from too much school work, and needed the energy of your peers to get you through the session, which setting would help you more?	160	47%	24%	29%

By choosing the face-to-face situation over DTVI by nearly a two-to-one margin, those participants who noted a difference are clearly stating that if emotional contact with others is desired, then something about the DTVI experience is lacking. In this

case, that something is the enthusiasm and expression of caring—the "energy" that is available through direct physical proximity to one's peers in a face-to-face encounter. This dampening of the social energy field should reduce the amount of positive regard that group members receive as a result of making a contribution to the group. In fact, the preponderance of higher TVI means over DTVI means on questions pertaining to participant experience seems to support this interpretation. But there may be a positive aspect of this as well. The dampening of emotion may also make criticism and disagreement less hurtful. In groups where conflict is prevalent, the increased social distance may actually serve to improve group cohesion (such as it is) relative to a face-to-face experience.

Of course, our questionnaire methodology doesn't measure the power of this "reduced social presence of others" effect. The fact that there were few significant differences between TVI and DTVI on this set of participant questions suggests that this effect is relatively minor. Or is it? Another possibility would be that the effect is strong but it influences collaborative learning in both directions. That is, reduction in social presence may also make it less risky to make a mistake in front of peers. Clearly, making mistakes is critical to learning. When mistakes are made in public there are more opportunities to receive corrective input. But each time an individual makes a mistake there is a lessening of their social capital in the eyes of their peers. If, through reduced social presence, the amount of social capital lost is also reduced, then the DTVI interface may actually assist participants in learning from mistakes by making it less costly to err in public. We asked students about a potentially embarrassing situation:

Question	n	Face-to-Face	DTVI	No Difference
15) If the facilitator asked you for your opinion and you didn't have one, which setting would make it easier to say that you don't know?	160	4%	38%	58%

In this question, we are assuming that it is more embarrassing to admit that you don't have an opinion than to give your opinion and find out it is inadequate. Being clueless says more about a person's capabilities, or lack there of, than a failed attempt. To the extent that admitting no opinion calls into question one has been holding up their end of the reciprocal contribution covenant, it presents a particularly high risk of losing face. Under the DTVI condition, reduced social presence produces less embarrassment than the analogous face-to-face encounter. To illustrate how subtle this effect is, consider a less embarrassing situation where one asks a question.

Question	n	Face-to-Face	DTVI	No Difference
4) If you wanted to ask a question about the lecture, which setting would be easier to ask the question?	159	24%	25%	51%

This item is a less embarrassing situation for a participant because the student is demonstrating a commitment to contribute to the learning discourse through asking the question. As a result, there is a minimal difference between face-to-face and DTVI on this question.

The contrast between these two items suggests that the reduced social presence effect might actually facilitate constructive action under certain social conditions. Clearly,

if one is clueless about lecture content that everyone else has an opinion on, one is in jeopardy of falling further behind one's peers in understanding the content. Making public one's ignorance is the first step in re-engaging with the content in order to make progress in understanding it. If, as the result of reduced social presence, participants invest less of themselves in the opinions of their peers, then there is less social capital to lose if one commits a social transgression.

Up to this point, all of our examples of the effects of reduced social presence have occurred in the context of interpersonal interaction. We have shown specific situations in which interacting through the DTVI interface made a variety of intentions easier to accomplish than in face-to-face encounters. While some situations might actually assist in accelerating the collaborative learning effect, the majority of the situations we have probed tend to reduce the participant's contribution to the group. We have emphasized interpersonal interaction as the location for documenting the effect of reduced social presence. We have demonstrated that the effects of reduced social presence are quite general.

While these results are far from conclusive on this point, they do suggest a pattern in which DTVI students appear to be the most removed experientially from the site of the social learning activity. This reduced social presence is a by-product of the distal disengagement produced by interacting through the DTVI interface. The scope of the effects of reduced social presence on participant perceptions is pervasive. In terms of discourse, DTVI participants interact slightly more, yet they consistently rate their discourse experience lower than their TVI equivalents. While it is more socially rewarding to make a good discursive move in a TVI group, it is easier to admit making a bad move in DTVI. Also, it is clearly easier to go "off-task" without letting anyone know in DTVI.

Because of the reduced social presence, the proactive interaction that is the lifeblood of the collaborative learning effect should be dampened. Yet, there was no statistical difference between TVI and DTVI on outcome measures of grade and only a slight difference in user satisfaction. So one could conclude from these findings that TVI and DTVI are equivalent. But we prefer the interpretation that TVI and DTVI yield comparable performance by taking slightly different routes. Our preference for this interpretation comes from the fact that, on average, each tutor was more discursively active in terms of the frequency of questions and statements in the DTVI setting than in the TVI setting. This is an interesting difference, since the overall experimental design controlled for tutor ability as a confounding variable by assigning the same tutor to both a TVI and a DTVI section. If distal disengagement were in effect, then it would make sense that tutors in their DTVI sessions might need to be more active to produce the same amount of student interaction as they had in their TVI groups.

In this section, we have explored the differences between the TVI and the DTVI experience caused by distal disengagement. We have shown that the DTVI experience can be characterized as having less social presence than the comparable TVI experience. But do these differences interfere with DTVI's ability to function as an effective small group collaborative learning format? Based on grade and user satisfaction, the answer would be no—the DTVI interface was remarkably successful in recreating the collaborative learning effect of TVI. From the standpoint of discourse, we can also conclude that the DTVI and TVI processes are extremely similar. Student surveys likewise reveal only few and minor differences between student reactions to DTVI and TVI. Since these discursive mechanisms are strongly

correlated with performance outcomes, our findings combine to create a clear and consistent picture of DTVI as a very successful strategy for collaborative distance learning. Where we did find subtle process differences—increased distal disengagement, disruptions in the back channel that signals mutual attending, and a relaxation of the reciprocity covenant—these issues were either subtle enough to not be detectable on our outcome measures or had corresponding positive impacts that counterbalanced their potential for disrupting the distance learning process.

Part 5: Conclusions

Summary and Implications of the Research

As we have shown, there is considerable prior research suggesting that communication technology can interfere with discourse. Since collaborative learning is dependent on discourse both for content and for group cohesion, we set out to determine whether the collaborative learning effect would be maintained in a virtual collaborative learning environment. We also searched for evidence of process differences between the face-to-face and DTVI conditions that might illuminate the impact of the technology on collaborative learning. Below, we have listed our four original hypotheses along with a brief summary of our findings for each.

We said that if the DTVI system did interfere with discourse, we would expect to see evidence of the following:

1. TVI students would outperform DTVI students academically and the collaborative learning effect (the performance gap between collaborative students and lecture students) would be smaller for DTVI students than for TVI students.

We found no difference in academic performance between TVI and DTVI students. We did find the expected difference between the academic performance of collaborative learning students and classroom lecture students. The DTVI environment appears fully capable of reproducing the collaborative learning effect, at least to the extent that learning is measured by university course grades.

2. DTVI students would have lower levels of satisfaction with the collaborative learning process.

The evidence on user satisfaction was mixed. Both TVI and DTVI students reported higher levels of satisfaction with collaborative learning than with traditional course methods. There was no difference in self-reported learning or likelihood of recommending the method to others. However, the TVI students reported enjoying the process more and were slightly more likely to say they would take another course using this method.

3. DTVI groups would have lower frequency of discourse.

Overall, there was a remarkable similarity in discourse patterns between TVI and DTVI. Where we were able to detect small differences, they were in the opposite direction of our original hypothesis. DTVI groups had more conversational turns than their TVI counterparts. We described them as "chattier." DTVI groups reported higher amounts of humor. Most of this increased interaction was outside the content domain. When limiting our analysis to exchanges with positive ratings for content, the only statistically significant difference was an increase in tutor questions.

4. DTVI students would exhibit lower levels of group cohesion

   Explicit measures of group cohesion showed no difference between TVI and DTVI groups. For instance, there was no difference in tutors' average group cohesion ratings of exchanges. Nor did students report differences in cohesion in survey questions. However, we did see evidence of distal disengagement, reduced social proximity, a relaxation of social discourse covenants, and lessened mutual attending behaviors. These issues suggest subtle differences in the social fabric of DTVI groups.

There are many lessons to be learned from this research project. These lessons are particularly compelling because of the size, duration, and real-world nature of the experiment.

1. Most importantly, our research shows that video-mediated communication can in fact support both the content and relational components of discourse that are necessary for effective collaborative learning. The collaborative learning effect is fully intact with DTVI, opening the door to the widespread use of more effective distance learning models than the lecture-based model currently being used.

2. Furthermore, we have demonstrated that video-mediated collaboration can generate high levels of user satisfaction. While the DTVI students reported enjoying their experience slightly less than the TVI students, they reported enjoying it much more than a typical classroom lecture.

3. With DTVI generating higher academic performance and more enjoyment than classroom lecture, distance learning no longer need be considered a poor cousin to face-to-face instruction.

All in all, we conclude that the communication perturbations of video-mediated communication using DTVI are both less evident and less salient than might have been expected based on past research. Whatever "noise" DTVI added to the communication process was subtle enough to not be explicitly recognized by students and to have minimal impact on social discourse. But some process differences did show up in student behavior and attitudes. For instance, while DTVI students reported feeling as connected to their group as did TVI students, they also admitted that if they were looking for emotional energy from their peers, face-to-face collaboration would be a superior environment. DTVI students showed signs of distal disengagement, rating both facilitators' content knowledge and course difficulty lower than their TVI counterparts. Finally, DTVI groups showed evidence of a weakening of the discursive reciprocity covenant. The impact of this reduced social presence and weakening of the reciprocity covenant is mixed. Lower reciprocity may have made it easier for DTVI students to hide or do other work instead of attending to the discussion. But it may also have made it easier for them to publicly take intellectual risks in front of their peers.

We cannot make a one-to-one match between elements of the DTVI interface and their impact in terms of social process. But we can say on the whole that the DTVI experience did not provide quite the same degree of "warm fuzziness" that face-to-face interaction provides. We do not know whether it is possible or—given the potential benefits of reduced social proximity (i.e., greater willingness to admit gaps in knowledge, etc.)—even desirable to create a virtual collaboration environment that does provide an equivalent feeling of human contact. But we can say that virtual

collaboration maintains a surprising amount of the group cohesion of face-to-face groups and that the collaborative experience is still very rewarding for participants, albeit perhaps in a different way than face-to-face collaboration.

Because of our comparative methodology and the large size of the study, it is tempting to make strong claims from this experiment. To be sure, we would expect the DTVI approach to perform as well as the equivalent TVI methodology and better than lecture for most college courses. But we would advise caution in generalizing these findings to other types of collaborative endeavors—for instance, project teams in industry. There are clearly some impediments to the proactive discourse required for strong collaboration. University courses typically have a reward structure geared for individual achievement. A good deal of research on reward interdependence [Slavin 1983; Johnson, Johnson, and Stanne 1990] has shown that the task incentive system can have a large effect of collaboration. Tasks that reward everyone in the group for the group's product create a much stronger collaborative effect than tasks in which participants meet as a group but receive credit for individual work. Under shared incentive conditions, participants would likely have less tolerance for behaviors such as slacking and free riding. Thus DTVI, which makes these behaviors easier, might be at a disadvantage. In addition, under these increased demands for collaborative performances, participants might be less forgiving about the subtle distortions in the social fabric engendered by the DTVI interface. Only additional research can shed light on how well the DTVI interface will scale up from a weak to a strong collaborative task.

We should also point out that this study opens up many areas for future research. We do not know, for instance, to what extent eliminating network transmission artifacts contributed to the relatively small amount of communication disruption we found in the DTVI environment. While much previous research has been done on the effects of latency, audio quality, etc., most of this research has focused on explicit, observable communication breakdowns. The effect of these breakdowns on group cohesion and other social aspects of collaborative discourse deserves more study. We also should point out that, in this experiment, each DTVI student was in a fairly quiet and interruption-free small room or cubicle. The distractions of office or home life might diminish one’s ability and willingness to attend to the group, should DTVI be brought to the user’s everyday desktop.

Lastly, in order to make direct comparisons with TVI possible, we designed the DTVI system with a spartan interface and a very limited feature set. In a sense, the DTVI system was crippled relative to what is easily achieved with technology. While it is not clear the extent to which any particular features would help (or hurt) the collaborative learning process, it is certainly possible—maybe even likely—that the effectiveness of virtual collaborative learning could be improved even further by creating a richer feature set. In fact, given that group cohesion remained surprisingly strong even with a bare bones interface, we wonder if there are features that could be built into future systems that would specifically target relational discourse and group cohesion. If so, then virtual collaborative learning might be able to produce a stronger collaborative learning effect than a face-to-face collaborative group.

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Appendix A: Instruments

Demographic Surveys

Demographic surveys were administered one time at the beginning of the experiment. This is how student attributes were obtained. The second version of the Demographic Survey, which added a few questions, was only administered one semester at Chico. Unfortunately, there is not enough data for these additional questions to make them useful.

Session Questionnaires

These instruments were administered several times during the academic year to get student feedback on the TVI and DTVI process and how students felt about course objects. Each new version of the Session Questionnaire added questions to the previous set. The third version was only given to Chico students in Fall 97, so again there is not a large enough sample size to use the additional questions. Because Session Questionnaires 2 and 3 were so similar, the data was aggregated in the database under the Session Questionnaire 3 label. There are no items in the database labeled Session Questionnaire 2.

Exit Questionnaires

These questionnaires were administered one time at the end of the session. As with the session questionnaires, the purpose was to learn how students liked the process and whether TVI students and DTVI students felt differently about their experiences or about course objects. The first exit questionnaire was designed by a professor at Cal Poly. While the second exit questionnaire did have some question overlap with the first version, it was really a different instrument designed by the SERA research team. The third exit questionnaire expanded on Exit Questionnaire 2, but was given only during the Fall 1997 quarter at Chico.

Member Rating Survey

One of the things members of a successful collaborative group must do is accurately judge the competency of fellow group members. Since prior research has shown that video-mediated communication can impact such ratings, this instrument was designed to find out if there was a difference in the level of agreement on competency between TVI and DTVI students. Note that no attempt was made to judge the accuracy of group members' judgments of competency, only the level of agreement.

Network Learning Questionnaire

This questionnaire was given to DTVI students only. The purpose was to find out specifically how they felt about DTVI compared to a TVI environment. Since the DTVI students had not participated in face-to-face TVI, they were asked to extrapolate from their past experience with small groups. For each question, students

were given a scenario and asked to choose which environment would be better given the scenario.

Lecture Questionnaire

This instrument was given to students in the lecture section of the course. It contains questions comparable to those asked of the experimental students. The purpose was to discern ways in which the attitudes and behaviors of the collaborative students differed from those of students in the regular lecture version of the course.

We replicate each survey essentially as the students received them, including any typographic or grammatical errors.

The following charts show which instruments were delivered in which semesters/quarters. Note that Cal Poly is on the quarter system and Chico is on the semester system, so the names of the academic periods don't always match. A copy of each of the listed instruments (except the logging data, which was entered directly into the database) follows.[11]

Cal Poly	Fall 95	Wint 96	Spr 96	Fall 96	Wint 97	Spr 97	Fall 98
Demographic Survey	x	x	x	x	x		x
Demographic Survey 2							
Session Questionnaire 1	x	x	x	x			
Session Questionnaire 2					x		x
Session Questionnaire 3							
Exit Questionnaire 1	x	x	x	x	x		x
Exit Questionnaire 2							?
Exit Questionnaire 3							
Member Rating Survey				x	x		x
Network Questionnaire (DTVI only)				x	x		x
Lecture Questionnaire							
Logging Data	X	x	x	x	x		x

[11] There may be minor formatting variations between the instruments as presented here and the actual versions given to students.

Chico	Fall 95	Spr 96	Sum 96	Fall 96	Spr 97	Sum 97	Fall 97
Demographic Survey				x	x		
Demographic Survey 2							x
Session Questionnaire 1				x			
Session Questionnaire 2				x	x		
Session Questionnaire 3							x
Exit Questionnaire 1				x			
Exit Questionnaire 2					x		
Exit Questionnaire 3							x
Member Rating Survey				x	x		
Network Questionnaire (DTVI only)				x	x		
Lecture Questionnaire							x
Logging Data				x	x		

Demographic Survey 1

Name: _____ Sex: ____

Birth date: ____/____/____

Phone #: _____ Student ID #_____
Email address: _____

Course #_____ Networked Group or Physically Present Group (circle one)

Group Session Time_____ Group Session Day:_____

English Language: Primary or Secondary language (circle one)
Number of years in college: _____

Major: _____ Is this course taken for your major? Yes No (circle one)

If yes, number of major courses credits already taken: _____

Estimate the total amount of time spent interacting with a computer daily: _____

During the last term, what percentage of your total study time was spent with one or more study partners: _____

Do you have any prior experience with distance learning? Yes or No (circle one)
If yes, how many months of distant learning experience altogether?
_____
What did you like and/or dislike about the experience?

Demographic Survey 2

Name: _____ Sex: ____

Birth date: ____/____/____

Phone #: _____ Student ID #: _____

Email address: _____

Course #: _____ Condition: TVI or DTVI-PC or DTVI-SUN (circle one)

Group Session Time_____ Group Session Day:_____

English Language: Primary or Secondary (circle one)

How difficult is it for you understand spoken English? (circle the number):

1 2 3 4 5 6 7

very difficult somewhat difficult very easy

How difficult is it for you to speak English? (circle the number):

1 2 3 4 5 6 7

very difficult somewhat difficult very easy

Number of years in college: _____

Major: _____

Is this course taken for your major? Yes or No (circle one)

If yes, number of major courses credits already taken: _____

Estimate the total number of hours spent interacting with a computer daily: _____

During the last term, what percentage of your total study time was spent with study partners? _____

Do you have any prior experience with distance learning? Yes or No (circle one)

If yes, how many months of distant learning experience altogether? _____

Have you participated in organized collaborative learning or peer study groups before? Yes or No (circle one) [If yes, about how many months total have you participated in peer study groups? _____]

Please read each question carefully, making sure that you are clear about who and what you are rating. Circle the number on the 1-7 scale that best represents your estimate. Once you understand what you are rating, go with your first response**. All of your responses are confidential. Your instructor won't see them.**

1) In a small class or seminar, how playful are you?

1	2	3	4	5	6	7
serious			average			clown

2) How much contact with your instructor, both in and out of class, do you need to get the grade you desire?

1	2	3	4	5	6	7
little			average			a lot

3) How talkative are you in small classes and seminars?

1	2	3	4	5	6	7
quiet			average			gregarious

4) How easy is it for you to ask questions when you are not sure about what is being said?

1	2	3	4	5	6	7
easy			average			difficult

5) How often do you show up late for class?

1	2	3	4	5	6	7
never			sometimes			a lot

6) Where do you typically sit in a classroom?

1	2	3	4	5	6	7
front			middle			back

7) How much class structure do you need to stay focused on learning the content?

1	2	3	4	5	6	7
little			average			a lot

8) How smart do your teachers usually think you are?

1	2	3	4	5	6	7
dumb			average			brilliant

9) How smart do your classmates usually think you are?

1	2	3	4	5	6	7
dumb			average			brilliant

10) How smart do you think you are?

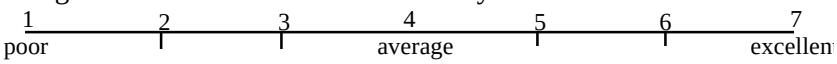
1	2	3	4	5	6	7
dumb			average			brilliant

Session Questionnaire 1

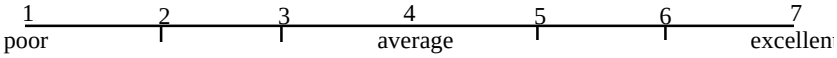
ID#: _____ Session Meeting Time _____ Date ____/____/____

For today's session, please take a few moments and anonymously answer the following questions. Fill in your birth date, the session meeting time, and today's date. Please read each question carefully, making sure that you are clear about who and what you are rating. Circle the mark on the scale that best represents your estimate. To minimize the inconvenience to you, please answer the scale questions with your first reaction. We would prefer that you spend the bulk of your time, carefully answering the short answer questions on the second page. Your comments on what works and what is problematic are extremely valuable for us as we modify the design to produce the best support for collaborative learning. All suggestions that you volunteer are welcomed. Thank you for your time and your insights.

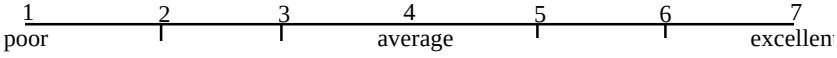
1) How knowledgeable on the course content would you rate the facilitator?



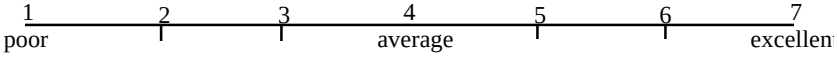
2) How "connected" do you feel towards the other members of your group?



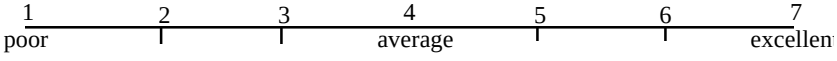
3) How well prepared were your fellow students for class?



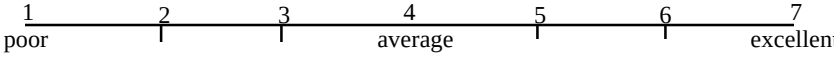
4) Estimate the value of your own contribution to the group discussion?



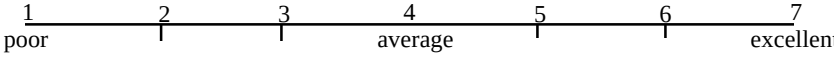
5) How responsive to the students' learning needs was the facilitator?



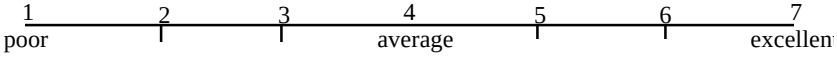
6) How would you rate your own preparation for class?



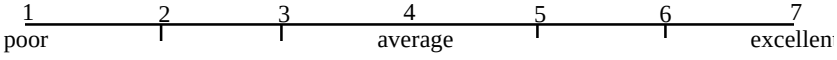
7) How well were students' questions responded to by the rest of the group?



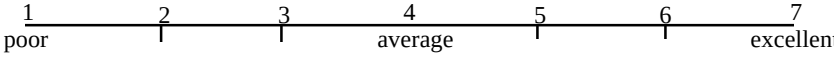
8) Overall, how informative was your peers' discussion of the lecture material?



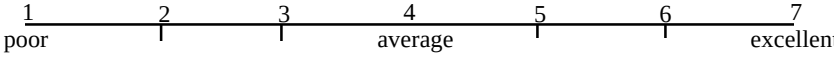
9) Estimate the group's responsiveness to your contributions?



10) Rate the group's ability to answer your questions?



11) In terms of overall satisfaction, how does this session compare with the typical class that you have taken at the university?

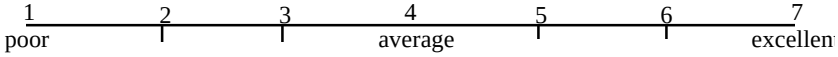


Session Questionnaire 2

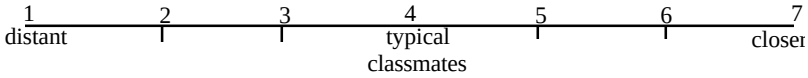
ID#: _____ Session Meeting Time _____ Date ____/____/____

For today's session, please take a few moments and answer the following questions. Fill in your student ID, the session meeting time, and today's date. Please read each question carefully, making sure that you are clear about who and what you are rating. Circle the mark on the 1-7 scale that best represents your estimate. Once you understand what you are rating, go with your first response. All of your responses are confidential. Your instructor won't see them.

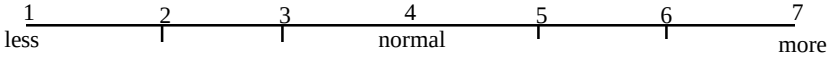
1) How knowledgeable on the course content would you rate the facilitator?



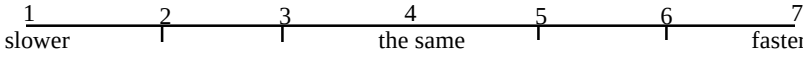
2) Relative to your typical classmates, how "connected" do you feel towards the other members of your group?



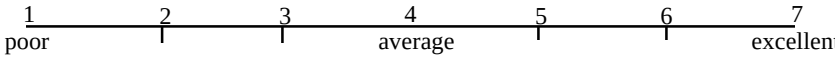
3) Did you feel that what you said today was valued by your peers ?



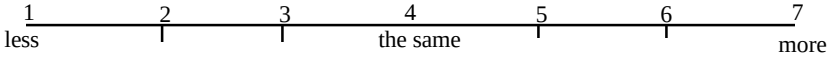
4) Relative to the typical lecture you have attended, did the time seem to go by slower, the same, or faster?



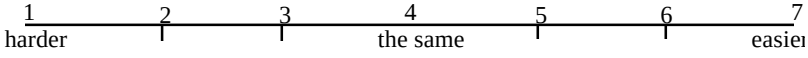
5) How responsive to the students' learning needs was the facilitator?



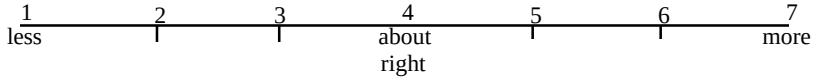
6)Did you find yourself talking less, the same, or more than you normally do with peers?



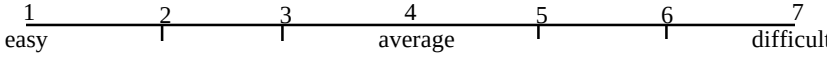
7) Is it easier or harder than normal to ask your group for assistance with the course content?



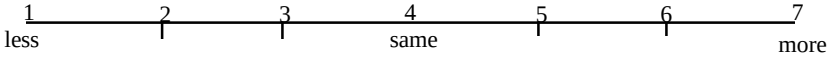
8)For today's session, would you prefer less or more pauses in the course tape for discussion?



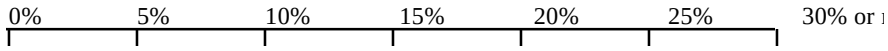
9) In comparison to the typical university course you have taken, how difficult was the course's content, ?



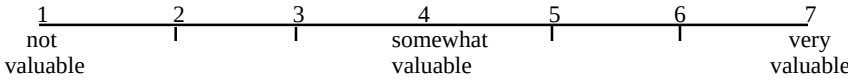
(10) Considering your typical level of playful behavior with peers, how playful were you today?



11) Estimate the percentage of time that your attention drifted from the content of the lecture or discussion?



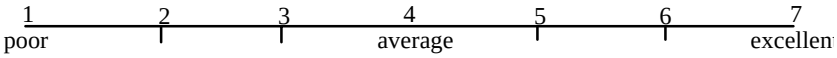
12) Is your group's "voice-over commentaries" during the course lecture valuable to you?



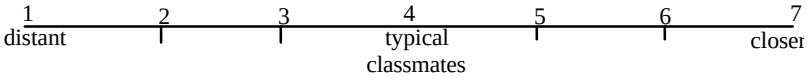
Session Questionnaire 3

For today's session, please take a few moments and answer the following questions. Fill in your student ID, the session meeting time, and today's date. Please read each question carefully, making sure that you are clear about who and what you are rating. Circle the mark on the 1-7 scale that best represents your estimate. Once you understand what you are rating, go with your first response. All of your responses are confidential. Your instructor won't see them.

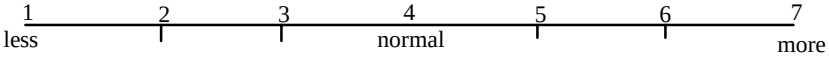
1) How knowledgeable on the course content would you rate the facilitator?



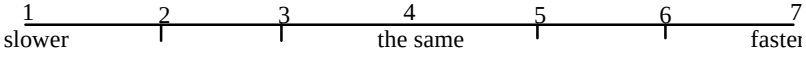
2) Relative to your typical classmates, how "connected" do you feel towards the other members of your group?



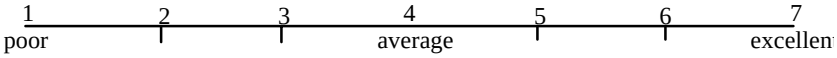
3) Did you feel that what you said today was valued by your peers ?



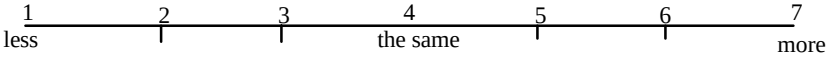
4) Relative to the typical lecture you have attended, did the time seem to go by slower, the same, or faster?



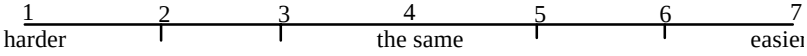
5) How responsive to the students' learning needs was the facilitator?



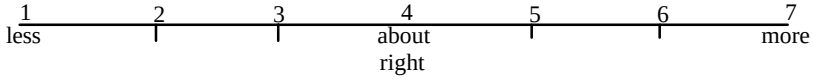
6) Did you find yourself talking less, the same, or more than you normally do with peers?



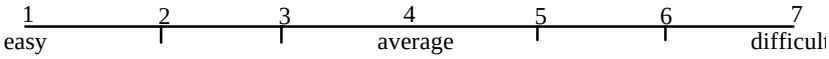
7) Is it easier or harder than normal to ask your group for assistance with the course content?



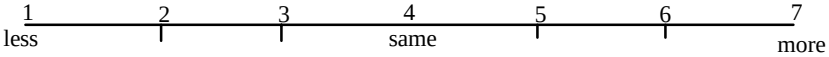
8) For today's session, would you prefer less or more pauses in the course tape for discussion?



9) In comparison to the typical university course you have taken, how difficult was the course's content?

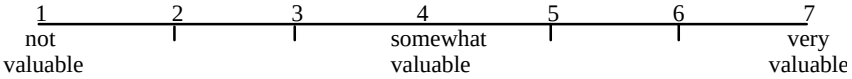


10) Considering your typical level of playful behavior with peers, how playful were you today?



11) Estimate the percentage of time that your attention drifted from the content of the lecture or discussion? _____**%**

12) Is your group's "voice-over commentaries" during the course lecture valuable to you?



Exit Questionnaire 1

Section Number: ____ ID: _____

Course Methods Questionnaire

This project is designed to understand how you feel about the teaching methods used in this course. Our interest is in understanding the use of information technologies in education. If you have any questions or comments regarding this project please contact Barry at bfloyd@oboe or at x6551. Individual responses will be confidential--only aggregated data will be presented in any research report. We will make our results available to anyone interested in the study. Thank you for your participation.

Directions:
In this questionnaire, we ask about your responses towards various aspects of the teaching methods used in this course. Answering this questionnaire only takes about 5 minutes to complete. When answering questions, please place your response between any two colons as shown below. Some questions may not be applicable for you particular section. For those questions, please circle NA (for Not Applicable)

I expect to eat dinner at a restaurant tonight.

Agree :_____:__X___:_____:_____:_____:_____:_____: Disagree

N/A Extremely quite slightly neither slightly quite extremely

(1) I felt comfortable asking questions in class.

Agree :_____:_____:_____:_____:_____:_____:_____: Disagree

N/A Extremely quite slightly neither slightly quite extremely

(2) The technology used in the class facilitated my understanding of the material

Agree :_____:_____:_____:_____:_____:_____:_____: Disagree

N/A Extremely quite slightly neither slightly quite extremely

(3) I learned more in this class than I have in other classes.

Agree :_____:_____:_____:_____:_____:_____:_____: Disagree

N/A Extremely quite slightly neither slightly quite extremely

(4) The number of students (class size) is about right for this type of class.

Agree :_____:_____:_____:_____:_____:_____:_____: Disagree

N/A Extremely quite slightly neither slightly quite extremely

(5) The questions I asked in class were adequately answered.

Agree :_____:_____:_____:_____:_____:_____:_____: Disagree

N/A Extremely quite slightly neither slightly quite extremely

(6) The facilitators added a lot to my understanding of the course material.

Agree :_____:_____:_____:_____:_____:_____:_____: Disagree

N/A Extremely quite slightly neither slightly quite extremely

(7) I felt comfortable asking to stop the video tape to review the material.

Agree :_____:_____:_____:_____:_____:_____:_____: Disagree

N/A Extremely quite slightly neither slightly quite extremely

(8) I enjoy working in small groups.

Agree :_____:_____:_____:_____:_____:_____:_____: Disagree

N/A Extremely quite slightly neither slightly quite extremely

(9) I paid attention to the lectures.

Agree :_____:_____:_____:_____:_____:_____:_____: Disagree

N/A Extremely quite slightly neither slightly quite extremely

(10) I would take another class using video taped instruction.

Agree :_____:_____:_____:_____:_____:_____:_____: Disagree

N/A Extremely quite slightly neither slightly quite extremely

(11) I prefer video tape instruction to a ë regular classroom experience.

Agree :_____:_____:_____:_____:_____:_____:_____: Disagree

N/A Extremely quite slightly neither slightly quite extremely

(12) The class typically was boring.

Agree :_____:_____:_____:_____:_____:_____:_____: Disagree

N/A Extremely quite slightly neither slightly quite extremely

(13) It is easier to pay attention to lectures when they are on video tape.

Agree :_____:_____:_____:_____:_____:_____:_____: Disagree

N/A Extremely quite slightly neither slightly quite extremely

(14) I found it easy to participate in class discussions.

Agree :_____:_____:_____:_____:_____:_____:_____: Disagree

N/A Extremely quite slightly neither slightly quite extremely

(15) The facilitators fostered a good learning environment.

Agree :_____:_____:_____:_____:_____:_____:_____: Disagree

N/A Extremely quite slightly neither slightly quite extremely

(16) The questionnaires were filled out honestly and openly.

Agree :_____:_____:_____:_____:_____:_____:_____: Disagree

N/A Extremely quite slightly neither slightly quite extremely

(17) The technology used in this class allowed me to participate more fully than what I would have done normally.

Agree :_____:_____:_____:_____:_____:_____:_____: Disagree

N/A Extremely quite slightly neither slightly quite extremely

(18) It was easy for the group to enter into discussions.

Agree :_____:_____:_____:_____:_____:_____:_____: Disagree

N/A Extremely quite slightly neither slightly quite extremely

(19) I would take another class like this one again.

Agree :_____:_____:_____:_____:_____:_____:_____: Disagree

N/A Extremely quite slightly neither slightly quite extremely

(20) Typically we resolved problems of understanding the material in the class sessions.

Agree :_____:_____:_____:_____:_____:_____:_____: Disagree

N/A Extremely quite slightly neither slightly quite extremely

(21) Everyone usually participated in our group discussions.

Agree :_____:_____:_____:_____:_____:_____:_____: Disagree

N/A Extremely quite slightly neither slightly quite extremely

(22) I was happy with the level of interaction I had with the course instructor.

Agree :_____:_____:_____:_____:_____:_____:_____: Disagree

N/A Extremely quite slightly neither slightly quite extremely

(23) The facilitators' behavior were reasonably consistent in their facilitating behavior from session to session.

Agree :_____:_____:_____:_____:_____:_____:_____: Disagree

N/A Extremely quite slightly neither slightly quite extremely

(24) It was easy for the group to enter into discussions.

Agree :_____:_____:_____:_____:_____:_____:_____: Disagree

N/A Extremely quite slightly neither slightly quite extremely

(25) I would recommend this class (and the way it was taught using technology) to others.

Agree :_____:_____:_____:_____:_____:_____:_____: Disagree

N/A Extremely quite slightly neither slightly quite extremely

(26) The questionnaires will be a good source of information about how this class was conducted.

Agree :_____:_____:_____:_____:_____:_____:_____: Disagree

N/A Extremely quite slightly neither slightly quite extremely

(27) I felt that I was not able to fully participate in this class because of the technology.

Agree :_____:_____:_____:_____:_____:_____:_____: Disagree

N/A Extremely quite slightly neither slightly quite extremely

(28) I am very enthusiastic about this class.

Agree :_____:_____:_____:_____:_____:_____:_____: Disagree

N/A Extremely quite slightly neither slightly quite extremely

(29) It was easy to follow the instructor's class presentation.

Agree :_____:_____:_____:_____:_____:_____:_____: Disagree

N/A Extremely quite slightly neither slightly quite extremely

Exit Questionnaire 2

All of the project staff want to thank you for your participation in our experiment. This is your final questionnaire! The ends of each scale, #1 and #7, represents the strongest opinions, while a #4 in the middle, is a neutral opinion on that question. Check, or circle the number that best fits your response to each question. All of these questionnaires are confidential. Your course instructor will not see your responses.

1) I would take another lecture class using this method.

1 2 3 4 5 6 7
disagree neutral agree

2) Taking the course in a small group was much more enjoyable than attending the lectures.

1 2 3 4 5 6 7
disagree neutral agree

3) I learned more in this format than I would have in the lecture section.

1 2 3 4 5 6 7
disagree neutral agree

4) In terms of getting the content, watching the videotape of the lecture is about the same as attending the lecture.

1 2 3 4 5 6 7
disagree neutral agree

5) I particularly enjoyed watching discussions between the lecturer and the class.

1 2 3 4 5 6 7
disagree neutral agree

6) It was easy for me to see the lecturer's transparencies and displays.

1 2 3 4 5 6 7
disagree neutral agree

7) I missed having personal contact with the instructor, before and after class.

1 2 3 4 5 6 7
disagree neutral agree

8) I wanted the instructor to witness my effort to participate actively in this course.

1 2 3 4 5 6 7
disagree neutral agree

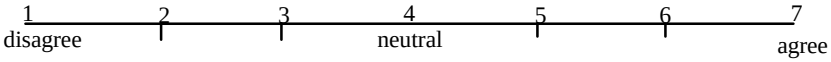
9) It was harder than normal for me to figure out exactly what my instructor would grade me on.

1 2 3 4 5 6 7
disagree neutral agree

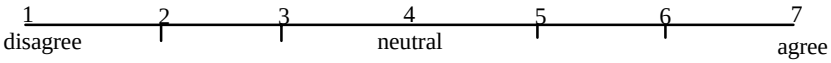
10) If the group had an audio tape of the lecture and the lecture slides, the videotape of the lecture wouldn't be necessary.

1 2 3 4 5 6 7
disagree neutral agree

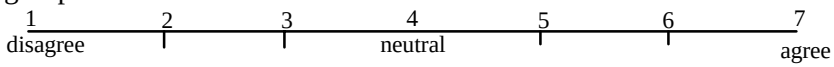
11) I found the lectures to be fast-paced and compelling.



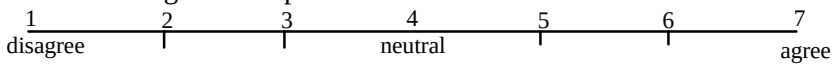
12) Humorous "talk over" remarks from my peers made following the lecture more difficult.



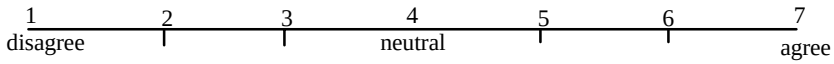
13) I would have asked more difficult questions, but there was no real expert in the group to answer them.



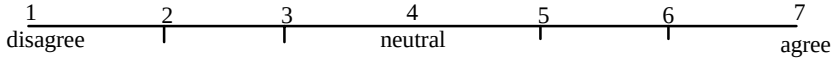
14) I preferred to have fun at really slow parts of the lecture tape, even at the slight risk of missing a minor point.



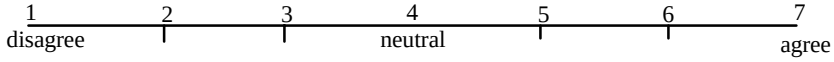
15) It was easier than usual to ask people to repeat statements that I missed or didn't understand.



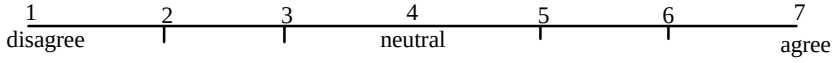
16) I asked more questions than usual for me.



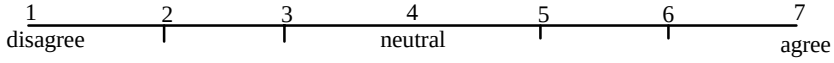
17) Hearing my peers' questions helped my own understanding of the topic.



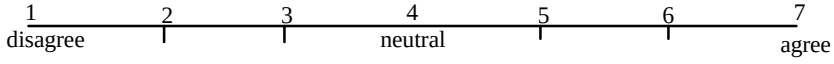
18) Asking too many questions got in the way of covering the entire videotape on time.



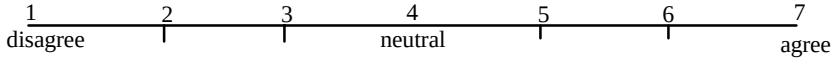
19) If I had attended the lecture, I would have asked as many questions.



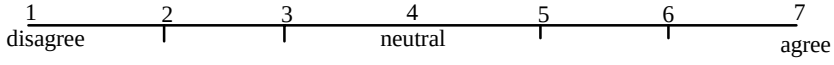
20) If my focus temporarily left the lecture, my peers would let me know if I missed something important.



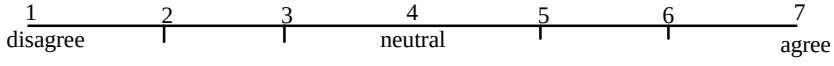
21) I found that my peer's talking-over the lecture tape was distracting.



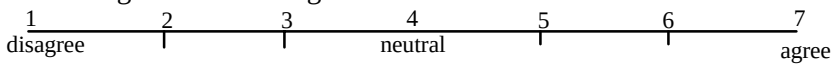
22) Talking over the lecture, alleviated the boredom of watching the videotape.



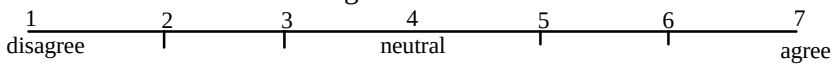
23) Too much discussion at pauses in the tape, forced the sessions to run overtime.



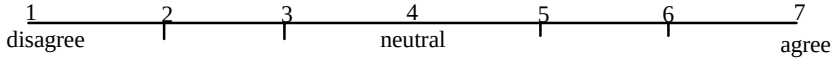
24) I would have learned more, if the facilitator would have stopped us from socializing so much during the lecture.



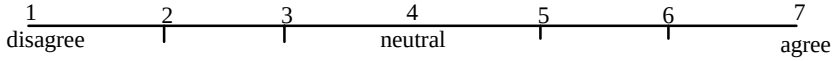
25) I was reluctant to talk during the playing of the tape for fear that I might interfere with someone's understanding of the lecture.



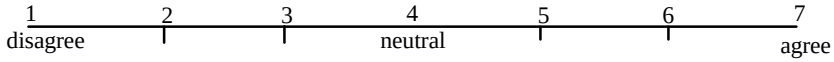
26) I preferred to discuss the content at pauses in the lecture tape.



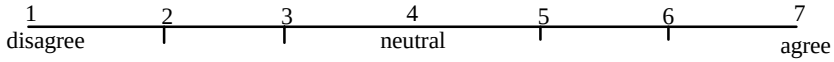
27) My primary job in this course was to memorize facts.



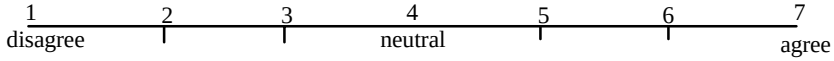
28) This course required me to apply the concepts to analyze a variety of situations.



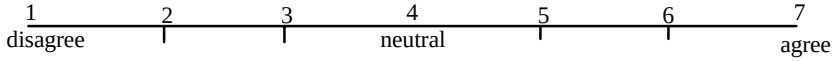
29) The lecture content provided many rich opportunities to discuss alternative positions with my peers.



30) It was important that the facilitator had already taken this course.



31) I wish the facilitator had tutored us more on the lecture content.



32) What percentage of the session time did I do something else while watching the lecture tape?

____%

33) What percent of achieving the grade I wanted required memorizing the course content?

____%

34) What percent of achieving the grade I wanted involved solving problems about the course content?

____%

35) What percent of achieving the grade I wanted involved applying the concepts to analyze relevant situations?

_____%

36) What percent of the sessions did I show up late?

_____%

37) What percent of the sessions did I miss?

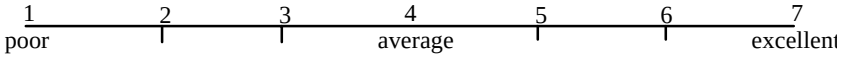
_____%

38) How many pauses of the videotape, did your group average per session? _____

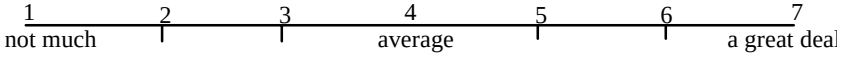
39) Rank each of the following components in terms of its contribution towards attaining the grade that you desired. So if you think that the facilitator was the most important contributor, place a 1 after "facilitator." If the quality of the lectures made the second highest contribution, place a 2 after "quality of the lectures." Each number ranking can only be used once. Rank all seven contributing factors.

Facilitator	_____
quality of transparencies	_____
quality of discussion with peers	_____
quality of the lectures	_____
humor to dispel boredom and maintain alertness	_____
getting answers to the questions you asked	_____
participating more actively in the small group setting	_____

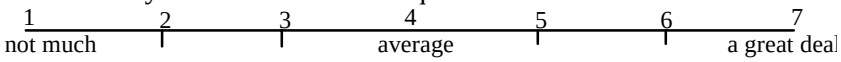
40) How would your rate your professor as an instructor?



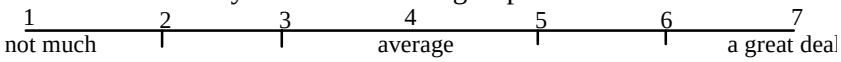
41) How intellectually challenging was the course content for you?



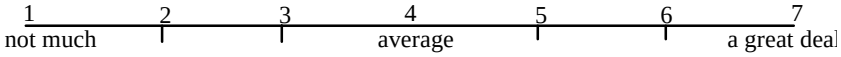
42) How much of my total attention was required to follow the lecture?



43) How comfortable were you with the other group members?

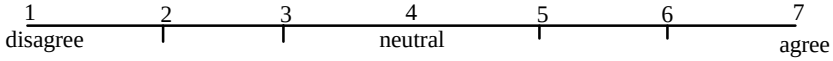


44) How much did your group assist you in getting the grade that you wanted?

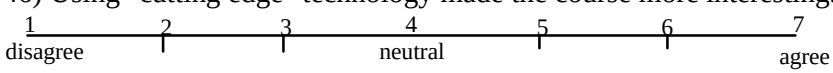


DTVI Participants Only

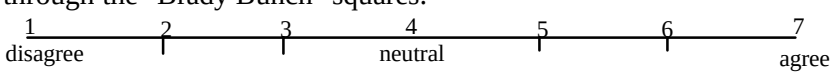
45) Being isolated from everybody else made the course more boring.



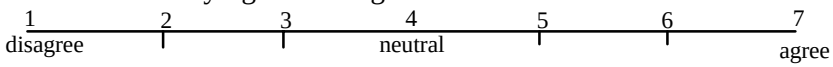
46) Using "cutting edge" technology made the course more interesting.



47) My primary connection with my group was through my headphones rather than through the "Brady Bunch" squares.



48) It was easy to jump into an ongoing conversation without interrupting a group member while saying something.



49) About how many times per session would somebody use the technology for entertainment? For example, rotate their image, stick their eyeball close to the lens, point the camera at the screen, etc.
___1 or 2, ___3 or 4, ___5 or 6, ___7 or 8, ___9 or 10, ___11 or 12, ___13 or more

50) How many sessions did I play a computer game while watching the lecture?
___1 or 2, ___3 or 4, ___5 or 6, ___7 or 8, ___9 or 10, ___11 or 12, ___13 or more

51) How many sessions did my fascination with the technology last?
___1 or 2, ___3 or 4, ___5 or 6, ___7 or 8, ___9 or 10, ___11 or 12, ___13 or more

52) During the playing of the lecture did you set your course volume, higher, lower, or the same as your group volume?

higher_____
lower _____
same _____

53) During "talk over" discussions of the lecture, did you set your course volume, higher, lower, or the same as your group volume?

higher_____
lower _____
same _____

54)At pauses in the lecture, did you set your course volume, higher, lower, or the same as your group volume?

higher_____
lower _____
same _____

55) What percentage of time did I leave my course window expanded?
_____%

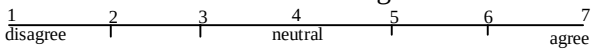
56) What percentage of the group's conversations took place while your course window was enlarged? _____%

57) What percentage of time did I leave my mic volume off? _____%

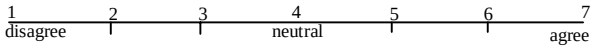
Exit Questionnaire 3

All of the project staff want to thank you for your participation in our experiment. This is your final questionnaire! The ends of each scale, #1 and #7, represents the strongest opinions, while a #4 in the middle, is a neutral opinion on that question. **Circle** the number that best fits your response to each question. All of these questionnaires are confidential. **Your course instructor will not see your responses.**

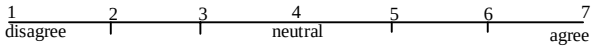
1) I would take another lecture class using this method.



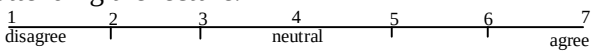
2) Taking the course in a small group was much more enjoyable than attending the lectures.



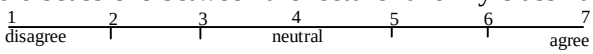
3) I learned more in this format than I would have in the lecture section.



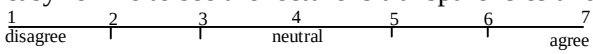
4) In terms of getting the content, watching the videotape of the lecture is about the same as attending the lecture.



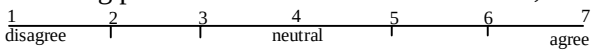
5) I found discussions between the lecturer and my classmates particularly valuable.



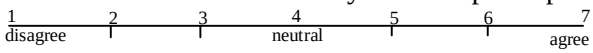
6) It was easy for me to see the lecturer's transparencies and displays.



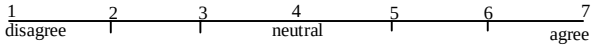
7) I missed having personal contact with the instructor, before and after class.



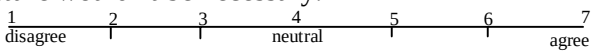
8) I wanted the instructor to witness my effort to participate actively in this course.



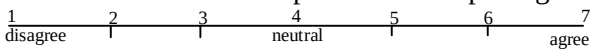
9) It was harder than normal for me to figure out exactly what my instructor would grade me on.



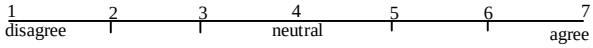
10) If the group had an audio tape of the lecture and the lecture slides, the videotape of the lecture wouldn't be necessary.



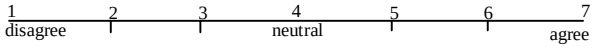
11) I found the lectures to be fast-paced and compelling.



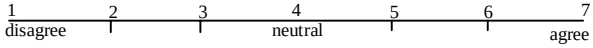
12) Humorous "talk over" remarks from my peers made following the lecture more difficult.



13) I would have asked more difficult questions, but there was no real expert in the group to answer them.



14) I preferred to have fun at really slow parts of the lecture tape, even at the slight risk of missing a minor point.



15) It was easier than usual to ask people to repeat statements that I missed or didn't understand.

1 2 3 4 5 6 7
disagree neutral agree

16) I asked more questions than usual for me.

1 2 3 4 5 6 7
disagree neutral agree

17) Hearing my peers' questions helped my own understanding of the topic.

1 2 3 4 5 6 7
disagree neutral agree

18) Asking too many questions got in the way of covering the entire videotape on time.

1 2 3 4 5 6 7
disagree neutral agree

19) If I had attended the lecture, I would have asked as many questions.

1 2 3 4 5 6 7
disagree neutral agree

20) If my focus temporarily left the lecture, my peers would let me know if I missed something important.

1 2 3 4 5 6 7
disagree neutral agree

21) I found that my peer's talking-over the lecture tape was distracting.

1 2 3 4 5 6 7
disagree neutral agree

22) Talking over the lecture, alleviated the boredom of watching the videotape.

1 2 3 4 5 6 7
disagree neutral agree

23) Too much discussion at pauses in the tape, forced the sessions to run overtime.

1 2 3 4 5 6 7
disagree neutral agree

24) I would have learned more, if the facilitator would have stopped us from socializing so much during the lecture.

1 2 3 4 5 6 7
disagree neutral agree

25) I was reluctant to talk during the playing of tape for fear that I might interfere with someone's understanding of the lecture.

1 2 3 4 5 6 7
disagree neutral agree

26) I preferred to discuss the content at pauses in the lecture tape.

1 2 3 4 5 6 7
disagree neutral agree

27) My primary job in this course was to memorize facts.

1 2 3 4 5 6 7
disagree neutral agree

28) This course required me to apply the concepts to analyze a variety of situations.

1 2 3 4 5 6 7
disagree neutral agree

29) The lecture content generated many discussions with my peers.

1 2 3 4 5 6 7
disagree neutral agree

30) It was important that the facilitator had already taken this course.

1 2 3 4 5 6 7
disagree neutral agree

31) I wish the facilitator had tutored us more on the lecture content.

1 2 3 4 5 6 7
disagree neutral agree

32) What percentage of the session time did you do something else while watching the lecture tape? ____%

33) What percentages of your grade were a result of the following (total should add up to 100%):

a) Memorizing course content ____%

b) Solving problems about course content ____%

c) Applying concepts to analyze relevant situations ____%

= 100%

34) What percent of the sessions did you show up late? _____%

35) What percent of the sessions did you miss? _____%

36) How many pauses of the videotape, did your group average per session? _____

37) Rank each of the following factors helping you attain the grade that you wanted. So if you think that the facilitator was the most important contributor, place a 1 after "facilitator." If the quality of the lectures made the second highest contribution, place a 2 after "quality of the lectures." Each number, **1-7, can only be used once**. Rank all seven contributing factors.

facilitator ..... _____
quality of transparencies ..... _____
quality of discussion with peers ..... _____
quality of the lectures ..... _____
humor to dispel boredom and maintain alertness ..... _____
getting answers to the questions you asked ..... _____
participating more actively in the small group setting_____

38) How would your rate your professor as an instructor?

1 2 3 4 5 6 7
poor average excellent

39) How intellectually challenging was the course content for you?

1 2 3 4 5 6 7
not much average a great deal

40) How much of my total attention was required to follow the lecture?

1 2 3 4 5 6 7
not much average a great deal

41) How comfortable were you with the other group members?

1 2 3 4 5 6 7
not much average a great deal

42) How much did your group assist you in getting the grade that you wanted?

1 2 3 4 5 6 7
not much average a great deal

43) How playful were you in this small class ?

1 2 3 4 5 6 7
not much average a great deal

44) How much contact with your instructor both in and out of class, do you require to get the grade you desire?

1 2 3 4 5 6 7
not much average a great deal

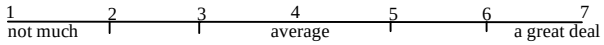
45) How talkative were you in this small classes?

1 2 3 4 5 6 7
not much average a great deal

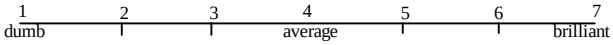
46) How easy was it for you to ask questions when you were not sure about what was being said?

1 2 3 4 5 6 7
not much average a great deal

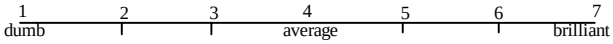
47) How much class structure do you need to stay focused on learning the content?



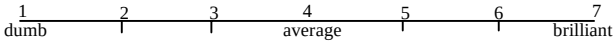
48) How smart do your teachers usually think you are?



49) How smart do your classmates think you are?

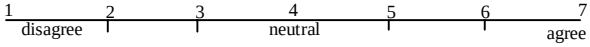


50) How smart do you think you are?

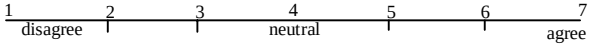


DTVI Participants Only

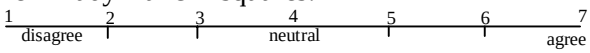
51) Being isolated from everybody else made the course more boring.



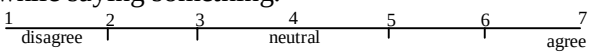
52) Using "cutting edge" technology made the course more interesting.



53) My primary connection with my group was through my headphones rather than through the "Brady Bunch" squares.



54) It was easy to jump into an ongoing conversation without interrupting a group member while saying something.



55) About how many times per session would somebody use the technology for entertainment? For example, rotate their image, stick their eyeball close to the lens, point the camera at the screen, etc.
___1 or 2, ___3 or 4, ___5 or 6, ___7 or 8, ___9 or 10, ___11 or 12, ___13 or more

56) How many sessions did you play a computer game while watching the lecture?
___1 or 2, ___3 or 4, ___5 or 6, ___7 or 8, ___9 or 10, ___11 or 12, ___13 or more

57) How many sessions did your fascination with the technology last?
___1 or 2, ___3 or 4, ___5 or 6, ___7 or 8, ___9 or 10, ___11 or 12, ___13 or more

58) During the playing of the lecture did you set your course volume, higher, lower, or the same as your group volume?

higher_____
lower _____
same _____

59) During "talk over" discussions of the lecture, did you set your course volume, higher, lower, or the same as your group volume?

higher_____
lower _____
same _____

60) At pauses in the lecture, did you set your course volume, higher, lower, or the same as your group volume?

higher_____
lower _____
same _____

Analog DTVI Only

61) What percentage of time did you leave your course window expanded?
_____%

62) What percentage of the group's conversations took place while your course window was enlarged? _____%

63) What percentage of time did you leave your mic volume off?
_____%

ID#_____ Facilitator _____ Session Meeting Time _____

Date ____/____/____

Member Rating Survey

Please take a minute and rate yourself and your peers on the following dimensions of group participation. Write in the names of your fellow group members in the columns below, reserving your own name for the last column. For each dimension, rank each member in your group in descending order. So if Mary was the best prepared each class session, give her the first ranking by placing the number 1 in her column. If John was the second most prepared, place a 2 in his column. If Bill and Debbie were tied for third in preparation, using your best judgment, make one third, and make the other fourth. Only one number can be assigned to each member. When you are done, fold them in half and place them to the provided envelope. All of your ratings will remain confidential.

	Member Names					Your Name
Best prepared for class						
Most content expertise						
Funniest						
Most helpful questions						
Most talkative						
Best explanations						
Best distractions						
Best contributions to your learning						

ID#_____ Facilitator _____ Session Meeting Time _____

Date ____/____/____

Network Learning Questionnaire

Congratulations! You are finishing your last computer networked session today. We would like your assistance in determining whether or not interacting with each other through the "Hollywood Squares" interface is different from interacting in the typical small group where everyone is physically present around a table. Below, are a series of questions about hypothetical situations that you might find yourself in as member of a Tutored Video Instruction group. In each question, we raise a hypothetical social wish that you might have, and then ask you to imagine whether the "Hollywood Square" interface, or your typical small group sitting around a conference table, would make it easier to accomplish you hypothetical wish. Don't worry if you haven't taken an equivalent class in a face-to-face, small group format. Just extrapolate what it would be like from all your prior experience interacting in groups. If both settings are equivalent for that wish, mark "no difference." Since you are the only people on earth with this experience, we are very eager to learn about the social experience of being a student interacting with your peers through the Hollywood Square interface.

1) If you wanted to work on something else during a slow part of the taped lecture, which setting would make it easier to get some other work done?
___ a small group sitting around the table
___ the computer networked small group
___ no difference

2) If you were going to make a wise crack about how lame the video lecture was, which setting would be easier?
___ a small group sitting around the table
___ the computer networked small group
___ no difference

3) If you wanted to watch someone in your class without being noticed by them, which setting would be easier?
___ a small group sitting around the table
___ the computer networked small group
___ no difference

4) If you wanted to ask a question about the lecture, which setting would be easier to ask the question?
___ a small group sitting around the table
___ the computer networked small group
___ no difference

5) If you found yourself spacing-out during the playing of the lecture tape, and wondered if you were the only one, which setting would make it easier to find out?
___ a small group sitting around the table
___ the computer networked small group
___ no difference

6) If you wanted to eat a snack during the lecture, which setting would make it easier?
___ a small group sitting around the table
___ the computer networked small group
___ no difference

7) If you wanted to make a side comment with the person next to you, which setting would make it easier?
___ a small group sitting around the table
___ the computer networked small group
___ no difference

8) If you felt slightly out-of-it, and didn't want to interact with anybody, which setting would make it easier to lay low?
___ a small group sitting around the table
___ the computer networked small group
___ no difference

9) If you knew the answer to someone else's question, which setting would make it easier for you to answer your peer's question?
___ a small group sitting around the table
___ the computer networked small group
___ no difference

10) If you found the lecture boring, and were looking for some kind of stimulation to keep you awake, but you didn't want to disturb others, which setting would be more entertaining?
___ a small group sitting around the table
___ the computer networked small group
___ no difference

11) If you wanted to make eye contact with one of your classmates, which setting would make it easier?
___ a small group sitting around the table
___ the computer networked small group
___ no difference

12) If you disagreed with what some else said, which setting would make it easier to voice your opinion?
___ a small group sitting around the table
___ the computer networked small group
___ no difference

13) If you weren't prepared for class, and you didn't want to be called on, which setting would make it easier?
___ a small group sitting around the table
___ the computer networked small group
___ no difference

14) If you said something to the group, and wanted to get a quick sense of whether they agreed or disagreed with you, which setting would make reading your peer's expressions easier?
___ a small group sitting around the table
___ the computer networked small group
___ no difference

15) If the facilitator asked you for your opinion, and you didn't have one, which setting would make it easier to say that you don't know?
___ a small group sitting around the table
___ the computer networked small group
___ no difference

16) If you wanted to go explain a diagram that you had made, which setting would make it easier for your peers to follow along?
___ a small group sitting around the table
___ the computer networked small group
___ no difference

17) If you wanted to tease one of your peers for a lame answer, which setting would be easier?
___ a small group sitting around the table
___ the computer networked small group
___ no difference

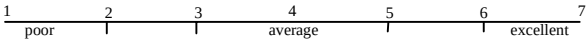
18) If you were exhausted from too much school work, and needed the energy of your peers to get you through the session, which setting would help you more?
___ a small group sitting around the table
___ the computer networked small group
___ no difference

Lecture Questionnaire

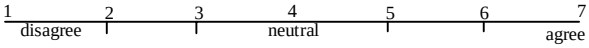
As you may know, groups of students have been taking this course remotely, by watching videos of the lectures that you attend. We would like you to take a minute to answer some questions about the course. We will be comparing your answers to the remote students to see if watching the action on a TV screen is different than being there. On the first set of questions, **circle the number** that best fits your response to each question. Since these questionnaires are confidential, please don't put your name on this page.

Your course instructor will not see your responses. Thank you for your cooperation!

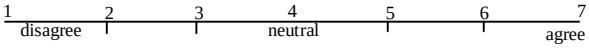
1) How would your rate your professor as an instructor?



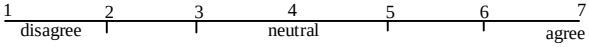
2) It was easy for me to see the lecturer's transparencies and displays.



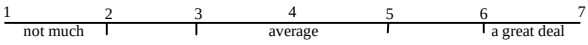
3) I found the lectures to be fast-paced and compelling.



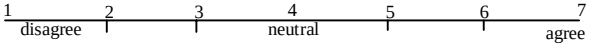
4) I found discussions between the lecturer and my classmates particularly valuable.



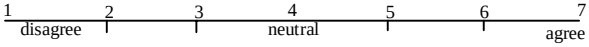
5) How intellectually challenging was the course content for you?



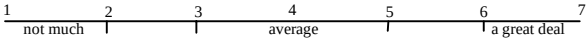
6) My primary job in this course was to memorize facts.



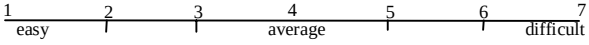
7) The lecture content generated many discussions with my peers.



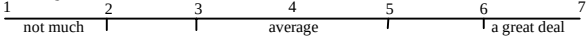
8) How much of my total attention was required to follow the lecture?



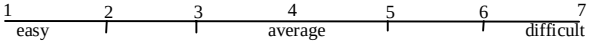
9) In comparison to the typical university course you have taken, how difficult was the course's content?



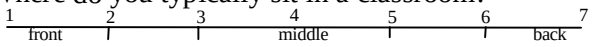
10) How much contact with your instructor, in and out of class, do you need to get the grade you desire?



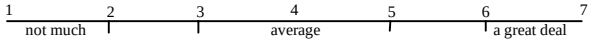
11) How easy is it for you to ask questions when you are not sure about what's being discussed?



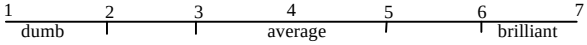
12) Where do you typically sit in a classroom?



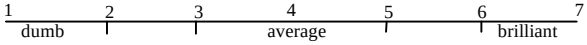
13) How much class structure do you need to stay focused on learning the content?



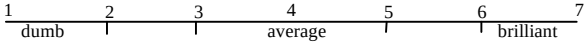
14) How smart do your teachers usually think you are?



15) How smart do your classmates think you are?



16) How smart do you think you are?



<u>For each question, **estimate** a percentage between 0 and 100%</u>

17) What percentage of the session time did you do something else during the lecture?

____%

18) What percentages of your grade were a result of the following (total should add up to 100%):

a) Memorizing course content ____%

b) Solving problems about course content ____%

c) Applying concepts to analyze relevant situations ____%

= 100%

19) What percentage of time did your attention drift from the content of the lecture or discussion?

_____%

20) What percent of the sessions did you show up late?

_____%

21) What percent of the sessions did you miss?

_____%

About the Authors

Michael J. Sipusic has a long-standing interest in the use of video in group contexts to promote learning. As a graduate student at the University of California, Berkeley, his dissertation topic on “Video Clubs” focuses on the professional development of a group of teachers who “talk shop” while watching videotapes of each other teaching. Prior to Video Clubs, he developed a holistic scoring system for reliably scoring classroom videotapes as part of a “Video Portfolio Project” sponsored by National Board of Professional Teaching Standards. As a result of incorporating video into his research methodology, he has also produced to videotapes: “A Teachers Video Club,” and “Videotaping Teaching and Learning: a Visual Guide.” He has presented tutorials on using video in research at the American Educational Research Association and the Computer Supported Collaborative Learning conferences.

Robert L. Pannoni is a co-founder of SERA Learning Technologies and served as the company's COO for seven years. At SERA, he designed, directed, and evaluated a variety of educational programs, including staff training for Sun Microsystems, Cisco and Raychem; anger management for at-risk juveniles; in-service training for K-12 science teachers; and distance learning courses for engineering students at Carnegie-Melon University and the University of Washington.

Rob has an MA from Stanford University in the Design and Evaluation of Educational Programs (1990). While at Stanford, Rob directed Tutored Video Instruction research and created Computing 1-2-3: The Basics of Personal Computing, a course for at-risk high school students. He also created The School Board, an online educational community hosted by the Stanford/Schools Collaborative. Prior to attending Stanford, Rob spent three years working for Automated Language Processing Systems, where he created training programs and designed the user interface for the company's flagship software. Rob is currently an independent consultant specializing in collaborative educational technology, distance learning and virtual communities.

Randall B. Smith is a Senior Staff Engineer at Sun Microsystems Laboratories. He received his Ph.D. in Theoretical Physics from the University of California at San Diego, then joined the Department of Physics at U. C. Davis where he taught for 2 years. He joined the Atari Research Laboratories in 1983, then joined the Xerox Palo Alto Research Center where he worked until 1991.

While at Xerox PARC he devised the "Alternate Reality Kit," a virtual world programming environment that supports creation of educational simulations. He spent a year at the Rank-Xerox Research Centre (“EuroPARC”) in Cambridge England where he built then experimented with a multi-user educational simulation environment. With David Ungar, he designed the Self programming language and joined Sun Microsystems Laboratories in 1991. He has authored over 30 publications on object-oriented programming, collaborative computing, and educational software. He is now head of the Interactive Collaborative Systems group in Sun Labs.

John Dutra is Director, Network Architecture for Sun Microsystems Laboratories. Since joining Sun Laboratories in Feb. of 1994, John has led the research in Distance Learning within Sun Labs. The distance learning project has had a primary focus on small group learning and interaction. The initial project, started in March of 1994, focused on the instructional effectiveness of Distributed Tutored Video Instruction with its face-to-face counterpart, Tutored Video Instruction.

In addition to distance learning research, John has also led research projects focused on the enterprise computing environment. These projects have led to the product introduction of new Internet gateway services and rapid application development tools in the marketplace.

Prior to joining Sun Laboratory, John spent over 22 years within IT in both the private and public sector. His background includes application development/support, network and system operations, information and database resource management, as well as end user services.

James F. Gibbons received the Ph.D. in Electrical Engineering from Stanford University. He joined the Stanford EE faculty in 1957, and was named Dean of Engineering in 1984. In 1996, he became Special Assistant to the President of Stanford for industry relations.

Gibbons has distinguished himself as the writer of the widely used undergraduate textbook *Semiconductor Electronics*, as author of over 300 scientific and technical publications, as a pioneer in both ion implantation and rapid thermal processing of semiconductors, and as the originator of the Tutored Video Instruction (TVI) process.

Gibbons is the recipient of many national awards, has been elected to the National Academy of Engineering, the National Academy of Sciences, and the American Academy of Arts and Sciences. He has served on committees advising the Presidential Science Adviser in the Nixon, Reagan, Bush, and Clinton administrations.

W. R. Sutherland is Vice President of Sun Microsystems, Inc., and Director Emeritus of Sun Microsystems Laboratories, the research center of Sun Microsystems Inc. (SMI). He joined the Labs at its inception in September of 1990.

Dr. Sutherland joined Sun Microsystems, Inc., from Sutherland, Sproull and Associates, Inc., an information and technology consulting firm. Prior to that Dr. Sutherland was employed by Xerox Palo Alto Research Center. He moved to Xerox from Bolt, Beranek and Newman, Inc., in Cambridge, Massachusetts where he served as Divisional Vice President. Preceding his work at BBN, Dr. Sutherland was a member of the Technical Staff and Associate Group Leader of the Digital Computers Group at the MIT Lincoln Laboratory.

Dr. Sutherland received his B.E.E in 1957 from Rensselaer Polytechnic Institute, and his M.S. and Ph.D. from Massachusetts Institute of Technology in 1963 and 1966, respectively.

He is currently a director of John Wiley & Sons, Inc., New York, as well as an advisor to Advanced Technology Ventures of Boston and Menlo Park.