# Enriching Asynchronous Learning Networks Through the Provision of Virtual Collaborative Learning Spaces: A Research Pilot

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## Abstract

*The research pilot presented here studied six student groups (N=30) using a CyberCollaboratory to perform the tasks necessary to complete a complex group project assignment in the asynchronous mode of communication. Each group was comprised of students from two major universities located over 500 miles apart and in different states. All students performed the task over a period of approximately four months. The task was comprised of subtask types, which can best be described using the model presented by Fjermestad, Hiltz and Turoff [7]. The group task required students to (1) generate, (2) choose, (3) negotiate, and (4) execute components for project performance. Preliminary findings of the study indicate that students can work productively and collaboratively in the asynchronous mode of communication, even at great distances, to produce exciting and valuable class projects given appropriate tools and process structures such as Group Decision Support Tools, Collaborative Document Production, Group Discussion (Computer Mediated Conferencing), E-mail, and Chat.*

**Key words: Asynchronous Learning Networks, Online Learning, Distance Learning, Collaborative Learning, Virtual Workgroup Environment, Web-enabled GDSS, Cooperative Document Production, Asynchronous Mode of Communication, Collaboratories, Cooperative Learning.**

"He [the schoolmaster] is awkward, and out of place, in the society of his equals. He comes like Gulliver from among his little people, and he can not fit the stature of his understanding to yours."

Charles Lamb "The Old and the New Schoolmaster," Essays of Elia (1832)

## 1. Introduction

As online educators we *are* Lamb's "schoolmaster", out of place trying to teach our students by using an electronic (conceptual) web in space where the tools and techniques learned over the centuries may no longer apply. The work presented in this paper is the first pilot preceding a series of field experiments designed to study the effects of using a web-based collaboratory as a support structure for Asynchronous Learning Networks (ALN).

The CyberCollaboratory, developed over the past four years, provides students with a collaborative virtual workspace where tools and structures have been embedded to control and structure group processes. The CyberCollaboratory has been designed to provide teachers of distance and asynchronous learners with a Web based workspace where team projects can be performed and collaborative learning can go on among distributed students.

When group process structures and methods for coordination are absent from asynchronous, collaborative technologies such as Computer

Mediated Conferencing (CMC) systems or Collaboratories in cyber space group members may lag behind or drop out of the collaborative efforts altogether. From previous research we know simple structures such as a meeting agenda, voting tools or facilitation can help an asynchronous group to achieve specific goals. Groups without these simple structures frequently flounder [6]. To that end we developed an environment with tools and process structures designed to enhance and support asynchronous collaborative work.

### 1.1. Historical foundations

Almost two decades ago Huber [13] [14] identified a perceived need for means to aid group processes in order to compensate for the limitations of human decision-making. The need for means and methods to aid group decision-making processes *has not* gone away but has evolved into a more complex set of needs than envisioned by Huber in the early 1980s. The need for group support tools has extended beyond decision support for face-to-face, traditional meetings, to include tools or environments for collaborative document writing, and group discussion (a form of Computer Mediated Conferencing [11]) suitable for use in the asynchronous mode of communication.

In this new millennium distributed teams or groups need virtual workspaces on the Web where collaborative tools are embedded to assist groups working, for the most part, in the asynchronous mode of communication. Synchronous tools such as chat can be provided for the occasional distributed meetings that require more immediate responses to questions or ideas than is possible in the asynchronous mode of communications [16].

### 1.2. Asynchronous collaborative learning

For students, group projects can be rich and enjoyable social learning experiences [9]. Learning made possible through the Internet has been compared to more traditional classroom learning experiences and has been shown to produce positive outcomes for online learning [1] [3] [4]. Although the teachers of distance and online learners are concerned about the issue of social isolation, little attention has been paid to providing these students with collaborative learning experiences that could mitigate the social isolation of online and distance education students.

According to Barua, Chellappa, and Winston [2] the Internet can "…serve as a highly effective foundation for a Collaboratory." By providing students with a convenient tool and media rich learning environment such as collaboratory, students can participate in group and collaborative learning experiences without having to coordinate and attend meetings. CyberCollaboratories also provide students with an opportunity to learn about new technologies, and to enjoy the interaction of a goal-oriented team [10].

The Web may also be able to provide an environment that is much richer than the traditional classroom. As a result, even students who are separated by time and place will be better off than students sitting in lectures given by professors clutching a handful of yellowed notes.

The benefits of asynchronous collaboration (different time/different place) include more than just convenience. The asynchronous mode of communication may be more effective in some ways than face-to-face communication. The delays between response and feedback that occur in the asynchronous mode of communication provide group members with the opportunity to reflect and think about a problem and examine more alternatives than is possible in a traditional face-to-face meeting because asynchronous meetings can take place over an extended period of time.

Asynchronous decision-making or collaborative processes are not subject to "pressure to closure" [6] [9] [10] [12], which may prevent students from exploring enough alternatives for adequate problem solving. Asynchronous technologies such as a CyberCollaboratory may also enrich learning and working experiences by providing an opportunity for people to interact more directly with one another outside of the classroom thus preventing the social isolation experienced by some distributed group members. Web based learning has been shown to enhance learning and help students perform better scholastically [1] [8] [9] [10] [15] [17]. Integrating the social benefits of collaborative learning into an online course or distance educational process through the use of collaboratories might further enhance the educational benefits and opportunities already offered by the Internet.

The CyberCollaboratory presented and discussed in this paper is a step toward fulfilling the needs pointed out by Romano et al. [16] and Huber [13] [14]. The pilot results presented here also show that our CyberCollaboratory can be an effective virtual workspace for supporting geographically distributed student teams working in the asynchronous mode of communication.

### 1.3. Evolution of a CyberCollaboratory

The CyberCollaboratory used for this pilot study evolved from a stand-alone same time/same place Group Decision Support Systems (GDSS) that included electronic flip charting, idea organizing and voting structures in 1993, to the fully developed Web-enabled Collaboratory today shown in Table 1. The CyberCollaboratory has environments for Collaborative Document Production, GDSS, Chat, and Group Discussion (a form of Computer Mediated Conferencing).

Project Management Advisor (PMA), a pilot environment for the purpose of teaching students project management skills through the integration of an expert system into the CyberCollaboratory, has been developed and is currently being expanded to include risk assessment, user involvement and earned value analysis. Currently PMA deals with the domain of knowledge having to do with information systems development. In the future, domains of project management knowledge will be added in the to serve construction engineering students as well.

## 2. The CyberCollaboratory objectives and functionality

Recently we have seen many web-based course management systems and e-Learning solutions developed and introduced, such as Blackboard, WebCT, and Learning Space. These e-Learning systems provide many features that the CyberCollaboratory also offers, i.e. discussion board, chat, file transfer, and announcements. However, these systems are lacking functions that we think would enhance the ability of distributed student teams to work on their group projects collaboratively such as decision support functions in the form of a group decision support systems (GDSS) component.

| | |
|---|---|
| **Phase I (1993-1995)** | **Face-to-Face (Same Time & Same Place) Meeting Environment**<br>• Level 1 GDSS<br>• Decision Room<br>• GDSS, E-mail |
| **Phase II (1995-1996)** | **Distributed Synchronous (Same Time but Different Place)**<br>• Level 1 GDSS<br>• LAN-based<br>• GDSS, E-mail |
| **Phase III (1996-present)** | **Distributed Asynchronous (Different Time & Different Place)**<br>• Level 2 GDSS<br>• Web-based<br>• CyberCollaboratory including GDSS, Document Production, Group Discussion, Chat, Project Management, E-mail |
| **Phase IV (Future Direction)** | **Intelligent Distributed Asynchronous**<br>• Level 3 GDSS<br>• Web-based<br>• Intelligent Facilitation Agent (Self-Facilitation) |

**Table 1. CyberCollaboratory Evolution**

In addition, most commercially available collaborative systems offer a particular focus. WebCT, Learning Space and Blackboard have neither the GDSS environment nor customized training environments that are available within the CyberCollaboratory. For example, the CyberCollaboratory has Project Management Advisor (PMA), which specifically addresses the teaching of project management where the domain of knowledge is systems analysis and design. In the future the domain of knowledge for PMA will be extended to include project management for construction projects and will address the needs of construction engineering students. The E-learning systems such as WebCT, Learning Space and Blackboard are templates within which a teacher can place course materials for individual student use. Students can perform the work without ever having to work as a team.

On the other hand the CyberCollaoratory has the unique purpose of serving as a teamwork environment where collaboration is forced through process structures and group coordination. One student *cannot* rush through a group decision process ahead of his or her team members by listing items during brainstorming and then immediately casting his or her vote. The system will open the voting function only after the team has determined the group has done enough brainstorming.

The primary goal of developing the CyberCollaboratory is to provide a comprehensive web-based, collaborative solution for distributed student work groups. The CyberCollaboratory can be used to provide students enrolled in online courses or online degree and distance learning programs with the opportunity to work on collaborative group projects without having to coordinate or attend meetings. These students can then benefit from the same rich and enjoyable, social learning experiences by working on a group project as do the on-campus, face-to-face students.

The CyberCollaboratory system chart shown in Figure 1 consists of an environment in which a variety of group support tools and process structures are embedded. The CyberCollaboratory was developed using the following software: Lotus Notes, Domino, Domino.doc, and Microsoft Project (the project management tool). The GDSS Tools, Project Management Advisor (PMA), and training were developed at the University of Illinois.

The CyberCollaboratory contains the following software environments as shown in Figure 1:

- Group Decision Support Systems (GDSS) including Electronic Brainstorming, Idea Organizing, Voting, and Session Management
- Project Management
- Intelligent Project Management (Project Management Advisor) and Collaborative Project Management
- Collaborative Document Production
- Asynchronous Group Discussion (Computer Mediated Conferencing)
- Real-Time Chat
- E-mail

## 3. The pilot study

For this pilot study our objectives were to validate *proof of concept,* to measure *user acceptance or satisfaction* and to demonstrate that the CyberCollaboratory can be used effectively as an asynchronous support environment (i.e. students would be able to complete projects as assigned). Face-to-face control groups were not used due to the limited number of groups available for the study. A series of field experiments is planned following the research pilots to assess the effectiveness of specific tools and environments as mechanisms for coordinating distributed groups engaged in collaborative learning experiences.

### 3.1. Group membership and sample selection

Each of six groups was comprised of five to six students drawn from two major universities located over 500 miles apart and in different states (Illinois and Nebraska). The professor teaching the course in which the students were enrolled recruited participants. Students were offered ten extra credit points for participation in the research. An alternative task was offered to those who did not wish to participate.

Initially 33 graduate students, 17 from one school and 16 from the other elected to participate in the research project. Later, three students dropped the courses in which they were enrolled citing personal reasons having nothing to do with the research.

Students volunteered (self-selected) to participate in the research; they were assigned randomly to groups as much as possible. A few students expressed preference for working together and were accommodated.

The students at one university were enrolled in a Systems Analysis and Design course and the students at the other were enrolled in a Decision Support Systems course. Students from both schools were assigned to each group to form six teams, comprised of approximately six participants, in most cases, three from each school.

### 3.2. The task

Each participant was enrolled in a graduate level MIS course, either the Systems Analysis and Design or the Decision Support Systems (DSS) course, with specific goals and teaching objectives. Therefore, a task was developed to combine the analysis and design of a software system with the development of a DSS extension for that system. This task was thought to provide the most benefit in terms of the teaching goals and objectives for the two courses.

More specifically, we thought the students in the Systems Analysis and Design course would benefit from designing a real-world software system, and the students enrolled in the Decision Support Systems (DSS) course would benefit from creating the DSS extensions for the software.

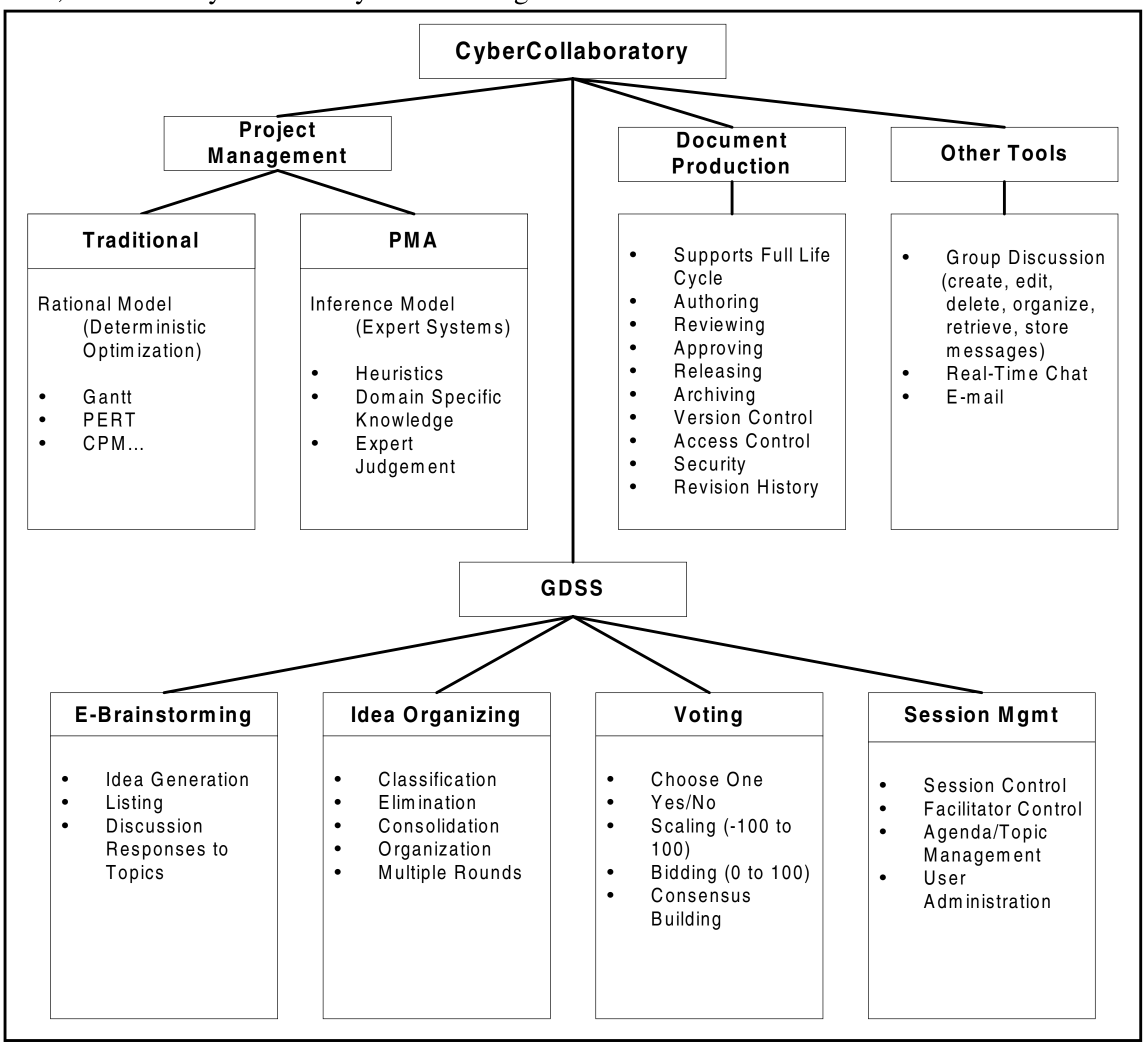


**Figure 1. The CyberCollaboratory System Chart**

0-7695-0981-9/01 $10.00 (c) 2001 IEEE

The task was tightly coupled enough to promote integrated activity between the geographically distributed members.

The student groups were instructed to select a software system to analyze and design, and then to create a DSS portion for the system. However, each student group was permitted to choose the specific software system for their project. The student groups were instructed to use the CyberCollaboratory tools to work on and complete their projects as required for the courses.

In most cases each group discussed the selection, scope, and types of software projects and then made a collaborative decision. In a few cases the students at one school or the other showed a preference for a particular system design project and the students at the other campus agreed.

All students performed the task over a period of approximately four months. The task was comprised of subtask types, which can best be described using the model presented by Fjermestad, Hiltz and Turoff [7]. The group task required students to (1) generate, (2) choose, (3) negotiate, and (4) execute components for project performance.

### 3.3. Survey instruments

The survey instruments used in this study to measure the efficiency and effectiveness of asynchronous technologies such as the CyberCollaboratory evolved and were validated over a 10 year period through the research efforts of Hiltz and Turoff at the New Jersey Institute of Technology (NJIT) and their graduate students, and the efforts of other researchers such as Watson [18] at the University of Minnesota. In 1998 Dufner and Kwon modified the survey instruments to fit this and other similar studies underway.

The instruments include a Consent Form, a Pre-test Questionnaire to obtain demographic information, a Training Evaluation Questionnaire to assess the participants' experience of the training to use the CyberCollaboratory, a System Expectation Questionnaire to assess the participants' expectations of the CyberCollaboratory system, and a Task Expectation Questionnaire designed to measure the subjects expectations regarding performance of the forthcoming task. A Post-test Questionnaire was administered after the task was completed.

### 3.4. Training, instrument administration, and facilitation

All of the groups attended a face-to-face (synchronous) training session where the Consent Form and Pre-test Questionnaire were administered before the training was begun. The hands on training in the use of the CyberCollaboratory followed. The System Expectation and Task Expectation questionnaires were administered directly following completion of the training session. The subjects were trained in the use of the entire CyberCollaboratory and were given a hard copy User's Guide. This User's Guide was also e-mailed to all group members because in its electronic form the table of contents and figures were hyper-linked for easy reference.

We did not facilitate student groups, preferring to let each group work through its issues and group processes with very little interference. Intervention was used only when necessary. Frequently, a student did emerge as a leader of these student groups.

## 4. Preliminary findings

Thirty students completed the research task to meet the requirements of their course. Only one of the research participants asked for an extension to complete his work. All groups completed their tasks as required for their courses.

### 4.1. Data analysis

The main objectives of this pilot study were to validate the research methodology and the questionnaires. The data analysis is limited due space limitations and the small number of groups studied in the pilot.

#### 4.1.1. Demographic Information

The pilot participants ranged in age from 22 years to 48 years. Of the respondents who completed the pilot 41.4% were females and 58.6% were males. Approximately one-third of the respondents were US citizens. Ethnic background varied somewhat; however, the groups were comprised predominately of Whites (37.9%) and Asians (51.7%).

The number of years of work experience ranged from 3.4 to 24.1 showing a wide range in experience. Approximately 83% of the respondents reported having medium to high experience in working in a group. Experience in making business decisions was somewhat lower, with approximately 62% reporting medium to high experience, as would be expected in a group where work experience ranged from very low to very high. Experience with computers and comfort with computers ranged high. Of the respondents, 86.2% reported feeling very comfortable with computers. This result was expected since all but one student were enrolled in a Management Information Systems (MIS) degree program.

### 4.1.2. Scale identification

The following scales, shown in Table 2, emerged during the data analysis: *Discussion Satisfaction* with a Cronbach Coefficient Alpha (rounded) of .83, *Problem Solving Satisfaction* with a Cronbach Coefficient Alpha of .88, *Satisfaction with the System* with a Cronbach Coefficient Alpha of .88, *Satisfaction with the CyberCollaboratory* with a Cronbach Coefficient Alpha of .91, and *Satisfaction with the CyberCollaboratory Tools* with a Cronbach Coefficient Alpha of .87.

### 4.1.3. Post-test means and standard deviations for scale variables

The standard deviations for most of the variables are very low, below or near 1 on a scale of 5, indicating most students were satisfied with the CyberCollaboratory, the CyberCollaboratory Tools, the System, and the Discussion and Problem Solving processes as shown in Table 3.

Table 3 shows the means and standard deviations for the scale variables. The means for all of the variables, which comprise the scale variables, are in the positive direction.

The results for *Discussion Satisfaction* and *Problem Solving Satisfaction* are also in the positive direction with means ranging from 3.6 to 4.2 on a scale from 5 (good) to 1 (poor) and 1.93 to 2.1 on a scale from 1 (efficient) to 5 (inefficient) respectively with composite means of 3.89 and 2.01 and standard deviations of .92 and .86 respectively.

Subjects reported the same level of positive responses for the variables that comprise the other scales, such as *Satisfaction with the System* and *Satisfaction with the CyberCollaboratory,* where the means range from 1.9 to 2.1 on a scale from 1 (good) to 5 (bad) and 3.7 to 4.1 on a scale from 5 (easy to learn) to 1 (hard to learn) respectively.

For the scale variable *Satisfaction with the CyberCollaboratory Tools* the means of the individual variables, which comprise the scale, are in the positive direction ranging from 1.87 to 2.3 on a scale from 1 (easy) to 5 (hard) with an overall composite mean of 2.06 and a standard deviation of 1.04.

**Cronbach Coefficient Alpha Values for Scales**

| | |
|---|---|
| **Discussion Satisfaction** | |
| for RAW variables: | 0.830418 |
| for STANDARDIZED variables: | 0.827464 |
| **Problem Solving Satisfaction** | |
| for RAW variables: | 0.878876 |
| for STANDARDIZED variables: | 0.881887 |
| **Satisfaction with the System** | |
| for RAW variables: | 0.882206 |
| for STANDARDIZED variables: | 0.885758 |
| **Satisfaction with the CyberCollaboratory** | |
| for RAW variables: | 0.912211 |
| for STANDARDIZED variables: | 0.914629 |
| **Satisfaction with the CyberCollaboratory Tools** | |
| for RAW variables: | 0.872524 |
| for STANDARDIZED variables: | 0.874543 |

**Table 2. Cronbach Coefficient Alpha Values for Questionnaire Scales**

**Means and Standard Deviations for Scale Variables (N=30)**

| Variable | Mean | Std Dev |
|---|---|---|
| **Discussion Satisfaction** *(Good, Effective, Satisfactory= 5 – Poor, Ineffective, Unsatisfactory = 1)* | 3.89 | .92 |
| **Problem Solving Satisfaction** *(Efficient, Coordinated, Fair = 1 – Inefficient, Uncoordinated, Unfair = 5)* | 2.01 | .86 |
| **System Satisfaction** *(Good = 1– Extremely Bad = 5)* | 1.99 | .83 |
| **Satisfaction with the CyberCollaboratory** *(Easy to learn, Friendly= 5 – Hard to learn, Impersonal = 1)* | 3.95 | .85 |
| **Satisfaction with the CyberCollaboratory Tools** *(Easy = 1 – Hard = 5)* | 2.06 | 1.04 |

**Table 3. Mean Values for Scale Variables**

### 4.2. Unsolicited feedback from subjects

Some initial unsolicited comments from the study participants are very encouraging. One student reported:

> *"I am very impressed with the CyberCollaboratory. It is a tremendous tool as it is now, and I can see tremendous potential for enhancements in the future. I would like to use it for the project I'm working on now through the Illinois Historic Preservation Agency. Is that possible? I don't know where you are in terms of testing, but we will be happy to give input if you need it. If you are licensing the product, I will consider that also within my budgetary constraints."*

Other CyberCollaboratory student users also commented as follows:

> *"The Cyberlab is easy to use and helpful. The GDSS helped everyone to have a voice and it helped build the team."*

> *"Document production really helped because my disk went bad and I was able to get all of the work from the Cyberlab repository."*

### 4.3. Student preference for tools

It is also noteworthy that student groups showed preferences for some tools over others, as shown in Table 4. The preferences for tools may indicate that certain types of tools are more appealing to groups based on the task type, group composition, or personal preferences.

## 5. Conclusions and future directions

The preliminary results presented in this paper are very encouraging. Students were able to complete their team projects, on time with a minimum of difficulty. Some students required helpdesk type support from the researchers during their initial few weeks of using the CyberCollaboratory. We also noted that groups where a leader emerged moved along more effectively and with fewer false starts than those groups where no leader emerged.

The strong positive feedback from the student groups who participated in the pilot study is also very encouraging because it shows that technologies such as the CyberCollaboratory can be used to provide richer educational experiences for students, especially those enrolled in online Web-based programs where there is little opportunity for group project work or group collaboration. The social benefits of collaborative learning, coupled with the educational advantages of using asynchronous technologies, make these technologies an asset to students studying in the asynchronous mode of communication via Asynchronous Learning Networks.

**Preference for Tools and Environments Based on Usage**

| Group | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| GDSS | Moderate | Weak | Weak | None | Moderate | High |
| E-mail | High | High | High | High | High | High |
| Chat | High | High | High | High | High | High |
| Group Discussion | High | Very High | High | High | Weak | High |
| Document Production | High | None | High | High | High | Weak |

**Table 4. Student Tool Preference**

Asynchronous group support tools embedded within Web-based Collaboratories present many exciting opportunities for future research. Issues such as technical and social coordination, group output and version control, security, testing for asynchronous operation, and tools are of interest to us.

Analysis of the final student projects from the pilot study and from the fall 2000 experiment will provide more information regarding performance of the student groups studied in this field trial [1] [8] [9] [10] [15] [19]. The very positive responses and feedback gathered from the post-test, coupled with the minimum number of requests for modifications to the system, show that the system can be expected to function with a high degree of certainty as expected. We know now that the CyberCollaboratory does work in the asynchronous mode of communication having been stress-tested for four months by six very active user groups.

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