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# Groupware for Collaborative Learning: A Research Perspective on Processes, Opportunities, and Obstacles

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**Abstract:** Although the technology exists to provide collaborative distance learning and training through electronic networks and groupware, little is currently known about appropriate ways in which to structure these learning environments. This article describes two research projects using groupware for collaborative learning activities. The first was a graduate business course conducted entirely online with geographically dispersed individuals. The second project investigated the use of groupware for collaborative writing and problem solving at a military academy with undergraduate students. Results and conclusions are presented to inform others working with computer networks and groupware.

**Keywords:** groupware, collaborative learning, electronic networks, distance learning

## 1. Introduction

Computer networks, a common feature of business, military, and educational settings, offer tremendous opportunities for groups to communicate. It is clear that they also present a manner in which to accomplish collaborative work and enhance distant educational experiences [Rohfeld & Hiemstra, 1994]. Technological advances have increased the expectations for distance learning; unfortunately, collaboration and interactivity are frequently lost in new electronic environments. Groupware, a new category of software, offers possibilities to enhance traditional communication technologies. Government funded education and training courses could be completed using a combination of technologies. Home bound or physically challenged individuals could gain access to resources and training. Instructors and trainees could access remote databases relevant to their work, while still connected to each other. Thus far, examination of the potential has been

focused in only a few areas, but the potential for distance learning is worthy of more serious investigation.

This paper will discuss the use of groupware to support collaborative distance education and create interactivity between and among groups of learners, regardless of their geographic location. It will report on research that examined the use of groupware in one graduate business course for geographically dispersed participants, and then describe ongoing research conducted with students enrolled in courses at one military service academy. The researchers investigated the benefits, problems, and serendipitous results of groups working together using new technologies and software. The paper concludes with recommendations for using groupware in collaborative settings.

## 2. Perspectives from Literature

Groupware refers to software that supports and augments group work, however, most investigations have focused on those capabilities useful in business settings, particularly among co-located populations who used the software synchronously, often in group decision activities [Valacich, Dennis, & Nunamaker, Jr., 1991]. The literature is only now beginning to expand the conceptualization of the use of groupware to include asynchronous and geographically distant activities.

It has become clear that technology changes the way in which people behave, according to Lea and Spears [1991]. They identified a change in informal and formal talk, and individuals' loss of identity and de-individuation. Tatar, Foster and Bobrow [1991] suggest consideration for what group work really means. It is not just many individuals working at computers at the same time, but it means „giving participants the ability to judge when it is appropriate to overlap, just as they judge the efficacy" of adding to verbal conversations [1991, p. 77]. It is necessary that group members learn and act out their roles in these situations [Olson & Bly, 1991].

Harasim [1990] summarized the characteristics of online courses as place and time independent, many to many communication that fosters real collaborative learning, and dependent on text based communications to promote thoughtful and reflective commentary. Other advantages to using this type of distance learning are the instantaneous and asynchronous communication, access to geographically isolated communities, multiple participation within activities, and cultural sharing of diversity and similarities among the people of our world.

Levinson summed up computer conferencing, an earlier type of asynchronous online learning, that set it apart from correspondence courses. It offers immediacy, encourages group exchanges (between teacher and students, among students] and it is also very different from computer assisted instruction as "computer conference is communicating through computers to other people, rather than to an already determined computer program" [Levinson, 1990, p. 7].

In an extensive examination of online education, Mason and Kaye found much to applaud. They noted,

> the provision of an opportunity, which never existed before, to create a network of scholars, "space" for collective thinking, and access to peers for socializing and serendipitous exchange. [1990, p. 23]

It is important to recognize that the environment in which a course is constructed is significant to the development of an online educational experience. According to Harasim, "Lessons gained over the past two decades of experience in network communication highlight the importance of designing the environment. Networlds are the intersection of social and technical systems; design involves both technical and social considerations" [1993, p. 29].

Learners report greater control and responsibility toward their learning; students also find that the act of writing demands greater reflection than speaking [Rohfeld & Hiemstra, 1994]. Several research and anecdotal studies have looked at online components of traditional courses and have concluded that these components substantially increase the communication between the teacher and the students, and among the students, when compared with similar writing classes without the computer communication component [Hartman, Neuwirth, Kiesler, Sproull, Cochran, Palmquist, & Zubrow, 1994; Hiltz, 1990; Schrum, 1995].

Regardless of the medium, electronic communication appears to foster collaboration and group interactions. In a study of distributed research, in which individuals who were geographically distant from each other collaborated on a research project, Olson and Bly [1991] concluded that "interpersonal computing supports people communicating and working together through the computer; it includes tools to support interaction separated by time and/or space as well as face-to-face interaction and meetings. … Work forced the boundaries of social place to extend beyond the boundaries of physical place" [p. 81].

The questions with which we began these research investigations included:

> What activities were supported and facilitated by using groupware in an electronic environment?
>
> What are the pedagogical strengths and weaknesses in this environment?
>
> What benefits and difficulties do participants report when using groupware for collaborative writing projects?

What benefits and obstacles do participants report when using groupware for collaborative problem solving?

What incidental or serendipitous learning occurred while using groupware for collaborative learning?

## 3. Project One

The purpose of this project was to examine one online course exploring the emerging phenomenon of teaching in a distance education model using groupware from the perspectives of the participants, the instructor, and the personnel who supported the course. This research specifically focused on a graduate business course offered in the Spring, 1996 by a major Graduate School of Business in the northeast. This course has been taught since 1983 in two traditional formats. In one format, students work with business organizations on an authentic competitive intelligence (CI) project, which provides them with hands-on experience. Unfortunately, this situated approach to the topic fails to allow time for coverage of a wide array of topics appropriate to the study of competitive intelligence. The second format is more traditional, based upon the lecture/discussion/exercise model. Readings, lectures, cases, exercises, and discussions provide coverage of a wide range of topics in this format, but leave no time for application projects.

The course described in this study attempted to combine the two models with the help of groupware technology. The instructor chose this technology-enhanced hybrid model because it allowed students to cover the range of material, while saving time through online discussions which could be spent upon application projects. In addition, this model allowed geographically-dispersed students to participate. Spread over the United States, these students would not have been able to participate otherwise. By combining a wide breadth of information with discussion and application, participants hoped to achieve a better holistic learning experience than they would have encountered through the traditional lecture/discussion/exercise model alone.

This graduate business course on Competitive Intelligences, conducted entirely online among geographically dispersed students, represented a unique opportunity to identify essential issues in the development and delivery of such courses, and provided individual and group reactions that serve to inform the evolution of online educational experiences. A few local students were advised to participate as if they were located at a distance.

### 3. 1 Methods

A case study approach is an appropriate manner in which to investigate this type of emerging phenomenon, particularly in a situation that is evolving and in which it is

important to ascertain the participants' understandings of the processes. Qualitative methods "are a source of well-grounded, rich descriptions and explanations of processes occurring in local contexts" [Miles & Huberman, 1984, p. 15]. This course represented a challenge for traditional research methods, especially considering that conducting research using ethnographic techniques via an electronic format is a fairly recent possibility; to do so in an ethical manner is an even greater challenge [Schrum, 1995].

Efforts were expended to triangulate the data sources and methods, and to include all possible opportunities to understand the experiences from as many perspectives as possible; these included analysis of written documents and group discussions, individual perspectives, and community memories [Lincoln & Guba, 1985; Miles & Huberman, 1984; Patton, 1987]. The text exchanges, lessons, and responses were captured for analysis. Individuals were invited to participate in individual electronic or telephone interviews that were designed to investigate the program processes, document variations among and between participants, and sought to understand and describe the events and resulting impacts from this course. These semi-structured interviews were conducted using naturalistic inquiry. The qualitative data were coded by the researcher and then compared, analyzed, and synthesized based on emerging themes.

Additionally, an evaluation survey was conducted using Likert-type scales and allowing anonymous participant responses. Respondents were asked to indicate their agreement on each statement across four options. These evaluation surveys were computed for means and percentages to understand participants' responses to the conferencing software, the study guides, and the online communication experiences. Descriptive data were also collected from the participants.

### 3.2 Discussion

The investigation offered a detailed description of the course from multiple perspectives; each constituency provided an understanding of the processes and outcomes of this course. The class consisted of eighteen students. Nine of these students were enrolled as graduate students in the business school. The other nine were widely distributed across the United States. Because of this circumstance, the class never met face-to-face.

The Terry Business College of the University of Georgia provided use of their World Wide Web-based groupware program *TCBWorks* . The interface of *TCBWorks* permits the establishment of separate student and professor comment files. These files, open to all students, allowed them to express opinions, suggestions, and observations about the course material and groupware. The interface also encouraged participants to set up discussions about an unlimited number of topics and subtopics, depending upon subjects and interests.

### 3.2.1 Class Session Description

Sessions were conducted in a consistent manner, all online. First, students reviewed the session outline, objectives, key concepts, readings, and topics for discussion. Second, the professor initiated the discussion by summarizing the session topic and raising points for deliberation. Third, students continued the online discussion, initiating ideas and following up on comments in the manner of a normal discussion. During the eighth week of the course, sessions were changed from asynchronous to synchronous discussions scheduled for the duration of one hour. This modification was made at the suggestion of several students.

### 3.2.2 Participants' Perspectives

The participants provided interesting comments and feedback through their survey and during the discussions. Most particularly, they appeared to concentrate on the opportunity to take the class, to interact with others, and to focus on the content. The specifics of the format, that is the online experience with groupware, appeared to be of less interest to these individuals than one might have expected.

### 3.2.3 Online Survey Component.

An evaluation survey, using Likert-type scales, was posted online toward the end of the course, and the energy expended to allow anonymous responses was worthwhile. Ten of the participants responded to the survey, which focused on three main topics.

The conferencing system was rated as relatively easy to use (1.5) on a scale where 1 = very easy to use and 4 = very difficult to use. Inserting comments was also rated as relatively easy (1.5) and navigating was only slightly less easy (1.8). One participant commented that it was "very simple. After a few false starts, I got the hang of things and have had no problems."

Questions about the study guide that accompanied the course asked participants to use a scale of 1 to 4 where 1 = strongly disagree and 4 = strongly agree with positive statements in the following areas. The guide was useful (2.9); the conferencing system was explained well (2.8); the organization of the discussion was clearly explained (2.7); the students felt prepared for participating in the discussion (2.6), and the assignments were explained clearly (2.8). One participant wrote, "The study guide was fine, there were a few times when I should have emailed Professor Prent but that was my problem, not the guide's." The feedback even included relatively minor suggestions: "I would suggest putting the assignment sheet on colored paper …"

When it came to an evaluation of the class interactions, students had fairly strong opinions. The learners felt comfortable participating in the computer conferencing

discussions (3.5); did not feel particularly connected to the other participants (2.5), felt that the instructor was easily assessable (3.1), and that technical support was fairly accessible (2.9).

Overwhelmingly, the majority of open ended comments were focused on the lack of quality class communications and interactions. One participant wrote, "I would suggest that for future classes in this area there should be scheduled times where everybody should be online in order to simulate an in-class discussion. My problems usually result in the lack of immediate feedback from colleagues." Another said, "I would prefer to set a time for everyone to be online at the same time. Also I have not had a sense of closure on any of the individual sessions." Finally, one other student summarized, "I am still not sure if the value added from being able to prepare a well thought out answer outweighs the dynamic atmosphere of a real time classroom."

3.2.4 Interview Data.

Participants in this course began with great enthusiasm, however, by the end of the course the number of active members had dwindled. The discussions were rich at the outset, with a high degree of energy devoted to ethical issues, definitions, and stories of practical applications of competitive intelligence. These discussions diminished considerably over the space of ten weeks, partially due to the effort required to participate.

Although many of the respondents to the survey asked for synchronous discussions, not everyone agreed that this would be beneficial. When the Professor arranged these live interactive chats, at least one participant was less than enthusiastic. He commented, "During the online discussion, someone who does not type quickly is at a disadvantage, the input is frustrating, and a spell checker is not available! "

Overall, comments from the students were positive. Specifics about the relationship among the students include the following, "Some of the members feel like friends." "Some had limited participation and then haven't shown up. I'm not sure what happened to some of them." Some of the students consistently participated, and one student said, "I have a perception of them as they think and where they are coming from."

A few suggestions were made by students. These included limiting the number of screens or topics, focusing the discussion more, and encouraging people to respond in a timely fashion to particular discussion areas. For example, one student mentioned that not everyone complied with a request to add their own questions or to respond. Another commented, "There were too many topics, and you have to keep checking to see if someone has posted a comment in every topic." The pressure to participate, rather than just passively read others' comments, may have contributed to the drop out rate. In spite of the difficulties, one student summed up

his feelings, "I have really enjoyed this course, would take another, and it was good content."

3.2.5 Instructor Perspectives

As a professor who was undertaking his first venture into teaching an entire class in cyberspace, Dr. Prent admitted apprehension along with excitement. Confident that the course material could be delivered in the groupware medium, he could not predict what to expect on a day-to-day basis. A positive prior experience with telecommunication-enhanced distance learning had piqued his curiosity about what a totally online course would be like.

For groupware enterprises, an extremely high level of infrastructure support is necessary. As with many technology projects, diverse skills, troubleshooting, and teamwork were needed to successfully complete the project. In this cyberclass, the instructor took on the role of a content expert; he worked more as part of a production team than just as a "teacher."

Emphasis needed to shift from a focus on the technology to coordinating a "diverse set of delivery skills." This course was the most structured in his career and he didn't expect this at first. This was a problem for someone who prefers less structure. Dr. Prent expected innovation to suffer, but "students and teachers alike will find ways to be creative."

With regard to online discussions, Dr. Prent reflected that, "Online discussions do not flow like face-to-face discussions." If there are too many subtopics (more than three), discussions are difficult to follow. Conversely, one category is too few, because discussion tends to vary widely and threads may go off in many different directions.

With *TCBWorks*, participants must shift from topic to topic regularly. This presents a cognitive problem: following multiple discussions simultaneously is a bit like a 3-ring circus. Prent commented,

> It is comparable to being at a party and trying to involve yourself in three semi-related discussions. You are not able to fully integrate yourself in any one of the discussions plus you run the risk of annoying the people you are talking with since your attention is divided.

He felt strongly that more research is needed on how to choose topics, how much variety to use, and how much time to spend on any one item. He wondered, "What is the tolerance level for participants concerning entering the software numerous times?"

Effective communication is essential in cyberspace because there is a lot of room for misinterpretation. Comments should be meaty but concise. Interactivity adds a dimension of difficulty to effective communication. Individual preparation is essential for effective online communication.

Given the setup of this course, Prent found it very difficult to gain a holistic sense of student personalities. This subjective dimension is arguably important for evaluation. Additional mechanisms for meaningful sharing are needed. Would he repeat this experience? "Definitely. I am more excited now than I was when we began this journey."

### 3.3 Results

The investigation offered a detailed description of the course from multiple perspectives. The data in this investigation provide more than an interesting glimpse into the perspectives of the participants and instructor of this course. Several recommendations can be distilled for others who might be interested in exploring teaching or learning via a distance network using groupware.

Students made suggestions regarding structure and focus of the course and environment. These included a request for fewer concurrent topics active in the software, inclusion of both synchronous and asynchronous activities, and devoting more energy to interpersonal interaction.

The content was consistently rated as substantial and fundamental to the students' purpose and goals. The participation of geographically dispersed individuals and use of groupware were secondary. Although a number of students abandoned the class, little energy was expended to find participants' reasons for dropping out. That information may be useful to gather in the future.

The professor, undertaking his first venture into teaching an entire class in cyberspace, admitted apprehension along with excitement. He reported that an extremely high level of infrastructure support is necessary. As with many technology projects, troubleshooting, attention to participants' diverse skills, and teamwork were needed to successfully complete the project. In this cyberclass, the instructor took on the role of a content expert; he worked more as part of a production team than just as a "teacher."

## 4. Project Two

These research projects were created to determine the viability of using groupware to support collaborative writing and problem solving within the context of projects that are assigned in courses that meet in a traditional face to face model. A military service academy represented a unique opportunity to study such uses, because all participants had access to high end technology, and yet they frequently enjoy little

possibility to work together on group projects. Researchers recruited the professor of a summer class to participate in the pilot projects.

After exhaustive study of many groupware packages, researchers and personnel at the Service Academy determined that LotusNotes would be the most desirable choice for the pilot and actual experimentation. Once this decision was made, effort was expended in creating scenarios and job tools, and ascertaining hardware requirements for the implementation.

### 4.1 Pilot Alpha Description

The class, a mandatory course focused on leadership, had twelve students. These students were enrolled during the summer primarily to reduce their fall semester load, for either sports or flight activities. The class met 15 times, for three hours per meeting. These students were all comfortable with computers, with electronic communications, and with group projects, however none of the 12 had previously used groupware.

The first pilot consisted of students entering a networked computer lab, but having no previous information about their activity. They were given a brief introduction to LotusNotes. Then they were randomly assigned to groups of four and were given three hours in which to collaboratively write a paper describing a policy decision that was unpopular and ways in which leadership might respond to this circumstance.

During this pilot the students were given three hours in which to complete the task. Unfortunately, the hardware and software posed enormous problems for the students. Computers crashed, the software refused to allow printing, and in total the perception of the groupware was largely negative. In spite of these difficulties, the groups did produce a collaborative paper, and managed to complete the assignment on time.

### 4.2 Pilot Bravo Description

The twelve students were divided into three groups of four students each by the instructor. Their task was to visit an organization in the local area, either a business or other enterprise, identify its organizational culture and leadership patterns, and then to collaboratively write about their experience. They were to assess the situation as they saw it, and to analyze the organization with respect to the leadership attributes they had studied.

They were again asked to use LotusNotes in the networked computer lab to complete this project, and they again had three hours in which to accomplish this. One of the groups completed this task on one day and the other two groups completed this task on a separate day.

4.3 Methods

Methods that were planned included Likert type pre- and post-test surveys of all participating students, electronic and on-site observations, semi-structured interviews with randomly selected participants and the instructor, and analysis of transcripts of group process work. Data analysis included statistical analysis of the pre- and post-tests, content analysis of the observations, interviews and transcripts of group processes. The qualitative data were coded by the researchers individually and then the researchers compared and synthesized the results. The utilization of multiple methods and peer interaction was designed to triangulate the research perspectives and increase the understanding of the participants' perspectives and response to the activities using groupware.

4. 4 Results

Unfortunately, the researchers feel that the difficulties with the hardware and software have severely compromised much of the statistical data. Given the difficulties with the hardware and software, and the artificial nature of the assignments, expectations were not extremely high. Nevertheless, data were generated and information was gathered that proved important and informed the planning for the next set of pilot projects. Many things became clear during the pilot projects.

Overall, an electronic network did enable collaborative and group activities. Interaction was fostered and students were individually responsible and accountable for that interaction, and for the ultimate product. Leadership patterns and roles did emerge although it is still unclear how the nature of the task impacted these roles. Strategies to accomplish the tasks were identifiable.

The data offered information about the tasks and the use of the groupware. The students felt that they could have more easily accomplished the task without using the network, or could have used the network with electronic mail and attachments. They also felt that even if the technology had worked perfectly it would not have been better than their traditional manner of group work. The reality of the situation (participants sitting in one room with multiple researchers observing them) and the artificial nature of their task (to accomplish something using technology that would have been easier done by shouting) was disconcerting.

From these pilots, it is also clear that the tasks given to the subjects must be relevant and authentic. Imposing quiet on the participants would have assisted with the experiment, but would have been difficult and increased the artificial nature of the test. Equally onerous for the students was the use of video cameras during the pilots and this was mentioned by all those who were individually interviewed.

Beyond the nature of the task, a great deal was learned about the planning and support necessary for actually carrying out a project using groupware. First, technical support is essential. All components of the technology must be running smoothly, operationally sound, and those hardware glitches that can be identified as potential hazards must be resolved. Second, it is clear that all personnel have a stake in the success of the project. This ownership of the project is essential if individuals are expected to learn new skills, to provide timely assistance, and to tackle difficult problems. Third, it would be extremely helpful to determine what participant prerequisites (for example, knowledge and skills of computer applications) are significant to the success of the activity.

## 5. Conclusions

Distance education represents a step toward lifelong learning so individuals can maintain professional expertise, share information, and work collaboratively. Technology now supports this with interactive networks and groupware, which allows synchronous and asynchronous discussions, collaborative activities, and group decision making. This research looked carefully at the emerging phenomenon of online and collaborative learning.

These research efforts represent a first step at investigating the use of groupware for collaborative learning experiences. This paper described one distance education course, delivered using an Internet and web based groupware product, from the perspectives of the students and instructor. It also provided information about the viability of groupware for collaboration within a single course setting to accomplish new activities.

These studies demonstrate that groupware holds potential for interactive collaborative learning, and distance education for many activities, but is not completely successful for all learners in all situations. The researchers, using information from this and other research, created a framework to identify applications of groupware, which include education, business, and research. Further research is needed to provide more information regarding best practices in using groupware for content specific learning, collaborative problem solving, and group processes. It is also important to identify those features needed and desirable within groupware packages (Appendix A).

Lessons learned from these experiences will inform future planning for using this and other groupware packages, and assist instructors in creating viable courses and assignments for both teaching and learning. Results suggest positive outcomes for content learning, and some strong suggestions for improving the structure and process of this type of online activity.

## References

[Harasim 90] Harasim, L. M.: „Online education: An environment for collaboration and intellectual amplification." In L. M. Harasim (Ed.), *Online education: Perspectives on a new environment* , Praeger, New York (1990) 39-64.

[Harasim 93] Harasim, L. M.: Networlds: Networks as social space. In L. M. Harasim (Ed.), *Global networks: Computers and international communication* , MIT Press, Cambridge, MA, (1993), 15-34.

[Hartman 94] Hartman, K., Neuwirth, C. M., Kiesler, S., Sproull, L., Cochran, C., Palmquist, M., Zubrow, D. „Patterns of social interaction and learning to write: Some effects of network technologies." In Z. L. Berge & M. P. Collins (Eds.), *Computer mediated communication and the online classroom* , Hampton Press, Inc., Cresskill, NY:. (1994), 47-78.

[Hiltz 90] Hiltz, R. S. „Evaluating the virtual classroom." In L. Harasim (Ed.), *Online education: Perspectives on a new environment* , Praeger, New York, (1990), 133-184.

[Lea and Spears 91] Lea, M., Spears, R.: „Computer mediated communication, de-individuation and group decision-making." In S. Greenberg (Ed.), Computer supported collaborative work and groupware, Academic Press, Inc., San Diego, CA, (1991), 155-173.

[Levinson 90] Levinson, P. „Computer conferencing in the context of the evolution of media." In L. M. Harasim (Ed.), *Online education: Perspectives on a new environment*., Praeger, New York, (1990), 3-14.

[Lincoln and Guba 85] Lincoln, Y. S., Guba, E. G.: *Naturalistic inquiry.* SAGE Publications, Newbury Park, CA. (1985).

[Mason and Kaye 90] Mason, R., Kaye, T.: „Toward a new paradigm for distance education." In L. M. Harasim (Eds.), *Online education: Perspectives on a new environment*., Praeger, New York, (1990), 15-38.

[Miles and Huberman 84] Miles, M. B., Huberman, A. M.: *Qualitative data analysis.* Sage Publications, Newbury Park, CA, (1984).

[Olson and Bly 91] Olson, M. H., Bly, S. A.: „The Portland experience: A report on a distributed research group" In S. Greenberg (Eds.), Computer supported cooperative work and groupware, Academic Press, Inc., San Diego, CA, (1991), 81-98.

[Patton 87] Patton, M. Q.: *How to use qualitative methods in evaluation,* Sage Publishers, Newbury Park, CA, (1987).

[Rohfeld and Hiemstra 94] Rohfeld, R. W., Hiemstra, R.: Moderating discussions in the electronic classroom. In Z. L. Berge & M. P. Collins (Eds.), *Computer mediated communication and the online classroom*, Hampton Press, Inc., Cresskill, NJ, (1994), 91-104.

[Schrum 95] Schrum, L.: „Framing the debate: Ethical research in the information age.“ *Qualitative Inquiry, 1*(3), (1995), 311-326.

[Tatar, Foster, and Bobrow 91] Tatar, D. G., Foster, G., Bobrow, D. G.: „Design for conversation: Lessons from Cognoter.“ In S. Greenberg (Ed.), Computer-supported cooperative work and groupware, Academic Press, Inc., San Diego:. (1991), 55-80.

[Valacich, Dennis and Nunamaker 91] Valacich, J. S., Dennis, A. R., Nunamaker, J. F.: „Electronic meeting support: The GroupSystems concept.“ In S. Greenberg (Eds.), *Computer-supported cooperative work and groupware,* Academic Press, Inc., San Diego, CA, (1991), 133-154.

Appendix A Groupware Investigation

I. Communication models needed
    A. Synchronous (chat mode)
    B. Asynchronous discussions
    C. Wide area networks
    D. Application document transfers
II. Research Support
    A. Data Collection
    B. Multiple views for analysis of the data
    C. Feedback modes
III. Problem Solving
    A. Posing complex problems for multiple audiences
    B. Ability to reconfigure groups, share solutions, and brainstorm
IV. Construction - Writing
    A. Support for collaborative writing
    B. Support for collaborative editing
V. Support for the processes - to include or exclude any of the following:
    A. Structures
    B. Models
    C. Teacher Support and feedback
    D. Flexibility to modify or replicate easily
VI. Ongoing support issues
    A. Hardware requirements
    B. Upgradeable / software
    C. Personnel requirements