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Distance Technologies in Collaborative Research: Analyzing the Successes and Barriers

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Abstract

This study investigates uses of distance technologies to support collaborative research among groups of teacher educators using online instruction to enhance their instructional practices. The primary goal of this study was to examine the successes and barriers of the use of distance technologies for collaborative research. The study includes a discussion of the advantages and disadvantages of particular distance communication tools. Data were collected via a survey administered in a Web-based format. Results indicate that e-mail and the telephone are considered the best facilitators of collaboration via a distance. The discussion reveals that technology infrastructures and participant skills play major roles in the selection of collaborative tools.

As distance education opportunities continue to expand in the higher education arena, so do opportunities to collaborate via distance through both communicative works and research. Collaboration is a recognized facet of the university framework. There has been much research on community building online, and the ways virtual collaborative teams communicate asynchronously and synchronously (DeSanctis, Wright, & Jiang, 2001; Pauleen & Yoong, 2001). With access to information being almost limitless on the Internet and through multiple digital libraries, technology can allow for easier collaboration via a distance as well as easier access to research material and resources (Murray, 1999). Communication technologies also provide opportunities to form collaborative networks or teams of teachers for the purpose of improving instructional procedures (Loucks-Horsley, 1998). The virtual extensions afforded for instructional and research collaboration via distance technology invites new avenues for innovation, ways of thinking, and challenges. Accordingly, this study investigates uses of distance technologies to support collaborative research among groups of teacher educators using online instruction to enhance their instructional practices.

Conceptual Framework: The Tools and Work of Collaborating Colleagues

Educational research has been afforded many advantages as technologies have extended possibilities for collaborative interactions via distance. Collaborative technologies can be broadly defined as those technologies enabling individuals and groups to communicate, collaborate, and interact to share knowledge and information (Sole & Applegate, 2000). Collaborative technologies can assist in virtual

communication. Electronic mail, videoconferencing, discussion boards, and traditional methods such as teleconferencing are just a sampling of the many alternatives that facilitate communication over a distance. Through such methods, researchers may communicate without the cost of travel and, perhaps, more easily transcend cultural barriers (Schwartz, 1999). Research may potentially be enhanced as collaborative technologies enable collaborators to contribute different skills, experiences, and perspectives to the collective work of the research team (DeSanctis et al., 2001). Presumably, uses of collaborative technologies are related to the collaborative nature of work conducted by the research team. Little is known, however, about the methodological aspects of research collaborations (Wasser & Bresler, 1996), and even less about the mediational role of collaborative technologies within this relationship.

In broad terms, a virtual collaborative team can be defined as "a group of people who interact through interdependent tasks guided by a common purpose that works across space, time, and organizational boundaries with links strengthened by webs of communication technologies" (Lipnack & Stamps, 1997, p. 7). To some extent, the work of a virtual team is not unlike that of a face-to-face collaboration. According to Lau, Sarker, and Sahay (2000), effective communication is the key to successful team collaboration and one of the keys to effective communication is how well team members are able to build and maintain their relationships. Research shows that it is easier to build relationships in a face-to-face environment rather than in a completely virtual one (Warkentin, Sayeed, & Hightower, 1997). However, it is possible through adept and attentive application of distance collaboration tools to facilitate a completely virtual team. Research indicates that computer-mediated collaboration teams often share relational information and commonly develop relational interaction over time (Chidambaram, 1996; Walther, 1997).

The virtual dimension of collaboration involves dealing with constraints uniquely associated with technical aspects of using electronic technologies. In using technology to communicate via a distance, research team members must have an adequate knowledge of the technologies to enhance and maintain communication. This is often considered an institutional staff development issue. However, in several cases, it depends on team member preference because some researchers favor certain communication methods (Pauleen & Yoong, 2001). In order to work and learn together, team members need a certain amount of understanding of the content, the procedure, and each other. However, in technology-mediated interaction, collaborators must also have a shared understanding of the communication technologies (Mulder, 2000), and the adequate technology capacity at their respective institutions to support such collaboration. Technological infrastructures can strongly impact the effectiveness and selection of communication technologies (Pauleen & Yoong, 2001). For example, software and hardware compatibility among team members can affect the choice of communication technologies. Recent advances in computer and telecommunications networking technologies have improved the information carrying capacity of networks, the transmission time, and the level of availability of the Internet to the world at large. Such technical improvements in computer hardware, software, and infrastructure have increasingly optimized conditions for the application of Internet-based tools to support collaboration via distance (Teasley & Wolinsky, 2001).

A Review of Previous Research Concerning Tools of Collaboration via Distance

Research collaboration via distance has been augmented by the Internet and communication technologies such as electronic discussion boards, electronic mailing lists, electronic messaging, the World Wide Web, and electronic mail. These types of communication technologies offer alternatives to traditional communication channels such as a simple telephone call or teleconferencing. According to *Electronic Collaboration: A Practical Guide for Educators* (1999), electronic collaboration is noteworthy to consider as it can be done anytime and from any location. This publication adds that electronic collaboration allows for a sustained effort where participants can propose, refine, and shape ideas themselves.

E-mail

While consistently found to be the most used tool of distance collaboration (Kalakota & Whinston, 1996; Pauleen & Yoong, 2001), there are advantages and disadvantages of e-mail use. According to Pauleen and Yoong (2001), significant aspects of e-mail use include universal platform, cost effectiveness, accessibility, and easy learning curve for research team members. Other advantages include succinct messaging and the benefit of being able to send attachments quickly and efficiently. Kettinger and Grover (1997) note that a significant feature of e-mail is that both sender and recipient control the timing of their portion of the communication. However, they add this can also be a disadvantage if lack of timeliness leads to poor communication or the undermining of the collaborative relationship. Another disadvantage presented by e-mail is the low context nature of the communication, which requires the writer to clearly articulate the intended message (Barnes & Greller, 1994). This can lead to important concerns being obscured by other points in e-mail communication (Pauleen & Yoong, 2001).

File Transfer Protocol

File transfer protocol, or FTP, is a method of transferring files from one computer to another over the Internet (Pallen, 1995). Files can be any size and contain text, graphics, audio, or video (Carmona, 1995). This communication tool lends itself to distance collaboration because researchers can store data files on a particular server for retrieval by other members of the research team. FTP is also an integral part of Web site design in that it can be used to readily transfer Web pages and related linked files to college-allocated Web space (Evans, 1999). The advantages of FTP include its ability to transfer files between disparate operating systems and its support of basic, Unix-derived file commands (Brumbaugh & Hart, 1993).

Videoconferencing

The concept of videoconferencing is not necessarily new in the world of collaboration (Perey, 1997). It is a virtual communication tool that provides an alternative to face-to-face meetings. It allows research team members to see and hear each other along with collaborating on shared documents. This recreation of face-to-face interaction

makes more complex levels of communication possible for collaborative teams (Townsend, DeMarie, & Hendrickson, 1998). However, in the past, the costs were very high, and the quality was not very good. Presently, new technology has improved the quality of transmission, and the costs are being reduced by Internet-based desktop videoconferencing (Pauleen & Yoong, 2001). Recent developments have allowed streaming audio and video forms of media to be compressed into manageable sizes (Zsiray, Smith, & West, 2001). The disadvantage is that without a broadband infrastructure, videoconferencing remains very poor in quality and reliability.

Discussion Boards

The discussion board, as a shared research team workspace, is useful for reporting on the status of work activities, posting questions, setting deadlines, and holding general conversations. A group discussion space allows easy review of group knowledge and enables a base of common knowledge to be built (DeSanctis et al., 2001). Clark (2000) states that one disadvantage to collaboration via group discussion boards is that when organization is not maintained, a form of information overload can occur. Kettinger and Grover (1997) note another disadvantage is the timeliness of the collaboration of information on discussion boards. DeSanctis et al. (2001) state that the most effective uses of discussion boards involve collaborating with focus and developing routines of communication and task completion.

Electronic Mailing Lists

Electronic mailing lists manage e-mail among a group of people and share many of the advantages and disadvantages of e-mail and discussion boards (Driscoll, 1998). Electronic mailing lists enable learners to choose the topics or threads of conversation that interest them and to ignore or delete those that are irrelevant. Messages related to a given topic can be posted over days or weeks. Conversations can also become entwined so that comments from one thread or topic can blend with another, causing confusion. Electronic mailing lists that are not moderated can become dominated by a few researchers or become neglected without a dedicated facilitator.

Instant Messaging Programs

When a lack of financial resources is a barrier to research collaboration, synchronous text-based messaging programs can be beneficial. Available without cost, these programs can provide a transcript of a virtual meeting, which can be stored for later reference (Pauleen & Yoong, 2001). A major disadvantage to instant messaging is the increased difficulty of coherence with a large number of participants. Instant messaging also does not lend itself to the use of formal meetings, yet can be used by research team members for informal communication, which strengthens collaborative relationships (Pauleen & Yoong, 2001).

Digital Imaging

Digital imaging is a new technology for capturing and presenting classroom data. The major benefit of this technology is the ability to involve more of the research community to interpret classroom data (Tangey, Holmes, & Fitzgibbon, 2000). The versatility of these images makes them exceedingly uncomplicated to use and distribute throughout various infrastructures and formats. They can be included in word processing documents, e-mail, and Web sites (Amber & Thies, 2001). However, in a report from Besser and Yamashita (1998), the complexity of the collective components of digital imaging (obtaining equipment, training, support, and software) was an overwhelming barrier for most professors.

Web Sites

Web sites can benefit collaborative research in numerous ways. The technology is widely available and accessible by anyone, anywhere, at anytime. For the virtual team, Web sites provide an important communicative and informational resource. They allow collaborators to archive textual, visual, audio, and numerical data in a user-friendly format (Townsend et al., 1998). Web sites also serve to coordinate interactions, keep other collaborators informed of the latest developments, and demonstrate new tools or discoveries (Teasley & Wolinsky, 2001). Because they are proven to be a rich source of qualitative information, Web sites make a significant contribution to the collaborative environment (Townsend et al., 1998). Disadvantages of Web pages are that they can be time consuming to update, and it is easy to have broken links and associated problems because a Web page or link was missed when they were updated (Hean, 1999). According to *Electronic Collaboration: A Practical Guide for Educators* (1999), another issue that may arise from the use of Web sites is the lack of appropriate training for designers.

Telephone/Teleconferencing

The conventional telephone and teleconferencing communication tools may be more comfortable for researchers to use and they generally do not carry the "aura or the baggage of new technology" (Pauleen & Yoong, 2001, p. 196). Teasley and Wolinsky (2001) reinforce this idea by stating that coordination of most geographically distributed research collaboration now is based on traditional means of communication such as the telephone. Perey (1997) states that researchers pick up paralinguistic clues from their team members, which can assist in collaborative relationship building. Perey adds that the telephone is also the backup communication tool of choice when other tools such as e-mail fail or when sensitive issues need to be discussed. Pauleen and Yoong (2001) note that one of the possible disadvantages of telephone use or teleconferencing is that they can become expensive. Another disadvantage of using this tradition communication tool is the aspect of time. The telephone does not reach across time differences, and many rounds of phone tag can delay projects (Rosch, 1995).

Word Processing Editing Tools

Collaborative editing is commonly used for documents that are created by more than one person or by a team. To facilitate this sort of distributed development, comments and changes can be added and tracked to facilitate the entry into or omission from the document. Multiple people can review a document, make changes, or suggestions without actually impacting the original text (Wright, Stewart, Wright, & Barker, 2001). This allows researchers to provide feedback and to participate in the peer editing process. For example, in Microsoft Word, editing features include inserting, deleting, and modifying text with Track Changes, accepting or rejecting changes, and inserting comments in a document. The major disadvantage of word processing editing tools is that there must be an assurance that all team members have an understanding of the tool.

Research Methods

Study Background

The present study is based on a cross-sectional survey of participants from the National Center for Online Learning Research (NCOLR)[1]. A convenience sample drew from members that had been assembled into research teams during the 2002 NCOLR Conference. NCOLR is a consortium of partners from numerous higher education institutions focusing on the research and development of best practices in teacher education via online education. NCOLR is most directly concerned with research to improve online education via the Internet, and determining what practices may be involved in making online learning more effective for students (National Center for Online Learning Research, 2001). Participants of the 2002 NCOLR Conference were formed into teams based on shared interest to explore a pedagogical approach (e.g., electronic portfolios, discussion boards, distributed teaching online, online instructional modules). The collaborative work of the teams varied in terms of the level of interaction as instructors or researchers, and also with respect to their uses of collaborative technologies to support their teaching or research practices. The three researchers conducting the present study formed a team based on a shared interest to explore relationships between uses of collaborative technologies and the collaborative work of the NCOLR teams.

Survey Instrument Designs

An online survey (see Appendix A) was designed to provide insights regarding successes and barriers of the use of distance technologies for collaborative research experienced by members of the convenience sample. A cross-sectional survey approach was deemed an appropriate research method for this study as it would allow for measurement of participants' practices and perspectives at a particular point in time (Cresswell, 2002). The survey included quantitative and qualitatively designed items to explore trends salient to the key questions of this study. Through a review of research and literature in the area of virtual communities and teams, a list of the most commonly used communication technology tools was compiled. The resulting list identified tools ranging

from traditional methods such as teleconferencing to nontraditional methods such as streaming audio and videoconferencing.

The survey investigated which tools team members used frequently to collaborate via distance. The survey also asked participants to qualify which tools were best facilitators or hindrances to their collaborative endeavors via distance. Respondents were also asked what they perceived to be individual strengths that they brought to the research team in terms of their technological, research, teaching, writing, innovation, task management, and data analysis skills; participants rated their strengths on a three-point scale with three being *high* and one being *low*. For the purpose of exploring the nature of their collaborative experience, participants were prompted to describe their collaborative research experience based on a metaphor. Lastly, the survey explored issues concerning time as an aspect of using collaborative technologies to support the teams' teaching and research activities.

Data Gathering and Analysis

The survey was conducted at a point when the NCOLR teams were concluding their collaborative team projects for the year. The survey was posted mid-March and was accessible online for 30 days. An e-mail message was sent to the 27 NCORL collaborative research team members inviting them to participate in the online survey. The survey was made available via a Web-based format so that participants who volunteered to participate in the study could readily access and anonymously submit the survey instruments by simply clicking on the URL provided in the e-mail message.

The survey was completed by 18 of the 27 NCOLR research team members. The quantitative results of each completed survey were tabulated through the Web-based survey program (see Appendix B). The program also archived the qualitative responses. The raw data generated via the survey software program was coded according to the printed page number, survey item number, and a letter assigned to each individual response. The research team members independently analyzed the survey responses, taking note of recurring trends as well as unique insights salient to the research study questions. The coded data sets not only aided the research team in comparison of their data sets, but would also provided an "audit trail" (Guba & Lincoln, 1989) within the reported study findings. Next, the team members shared their analyses to compare the commonalities, differences, and viability of their coded data. Codes that seemed to reflect similar descriptors were grouped to form categories. A number of categories were readily interpreted as cohering around a focal point or "theme". Some codes however introduced unique characterizations either because it was a distinctive contribution by a respondent (such as the individual's choice of metaphor), or because a research team member brought a different research perspective to the analytical process—an expected situation given all participants' diverse teaching and research experiences. In cases where a research team member brought a novel interpretation, the team revisited the data to confirm or disconfirm the viability (Guba & Lincoln, 1989) of such unique interpretations. The research team thought it was important to recognize instances of differing and divergent perspectives to move beyond a generalized account and to reflect the contextual nature of collaborative teaching and research. Thus a more collective interpretive scheme was used to bring together unique data categories and interpretations

as thematic portraitures. Accordingly, the study results, which follows in the next section, provides a summary of quantitative trends and highlights drawn from qualitative responses organized within three thematic sections: *Strengths Within the Collaborative Relationship, Tool Use and Constraints*, and *Portraitures of Collaborative Work via Distance*.

Results

Theme 1: Strengths Within the Collaborative Relationships

The research team was interested to explore aspects of expertise and prior experiences as these might be important to the work of the team. The team wondered, for example, if it mattered that team members had job security or were novices in their profession? Did team members have confidence in their teaching as well as with their use of collaborative technologies? If a team member was a novice researcher, might attempts to collaborate via distance compound the challenges of learning to do research? Accordingly, responses from the survey were analyzed to generally describe aspects of prior experiences and expertise, and to observe trends that might be important to the team endeavor.

Survey respondents consisted of 6 professors, 8 associate professors, and 4 assistant professors; 12 of these faculty members were classified as tenured. An additional 5 were tenure-track with only 1 respondent classified as non-tenure track. Two thirds of the survey participants were female. Eight respondents indicated that they were between the ages of 41 and 50. Six were older than 51, and 4 were 31 through 40.

The survey included items to explore feelings of novelty associated with participants' teaching experience and technology use. Several survey items asked participants to rate on a three-point scale various strengths they brought to the research team. The areas that the collaborative researchers rated as being their strongest were teaching and innovation. Teaching contained the highest average response of 2.7 with 14 (77.8%) of the participants indicating they were highly skilled in their teaching, 3 (16.7%) indicated an average level, and 1 (5.6%) indicated low skill level. Innovation also had an average response of 2.7 with 12 (67%) of the participants indicating high skill level, and 6 (33%) indicating an average skill level. Technology represented the area in which the scholars indicated as their lowest skill aspect. The average response to this skill was 2.3 with 7 (38.9%) participants indicating that they were highly skilled, 10 (55.6%) noting average ability, and 1 (5.6%) indicating a low level of skill.

The survey similarly explored the prior experience team members had in terms of conducting research. Eighty-nine percent (16) of the respondents indicated they had previously participated in a collaborative research activity; however, only 56% (10) of the respondents indicated that their research endeavors involved collaboration via distance. The survey did not specifically distinguish between scientific versus educational research experience; however, it was apparent, at least for some participants, that the NCOLR project was a highly novel introduction to educational research as "action research":

> My previous experience in research was primarily biological with little experience in behavioral investigations. Consequently, this has been a barrier that often prevents most scientists from conducting action research or behavioral approaches to investigations. I think this is one obstacle that many professors have when it comes to designing and conducting valid studies with regard to educational based practices.

Another team member indicated that collaborative technologies afforded opportunities to move beyond a place of research isolation to experience new research approaches: "Previously, most of my research activities have been with non-human subject materials. Consequently, this type of research by myself would not be occurring if online collaborative didn't exist."

The survey responses indicated participants represented a wide range of qualities with respect to their career status, technology use, and teaching and research experiences; however, it was not apparent that these diverse characteristics constrained the work of the team. In several instances, respondents suggested that the strength of the team is a collective quality. This interpretation follows the traditional saying that "a chain is only as strong as its weakest link," similarly expressed by a respondent:

> As with any group interaction, the quality of the people who make the team ultimately determines the success of any project. It is extremely important to be a part of a team that is committed to carrying a fair share of the workload, including innovative problem solving. If you have this then most of the technical issues simply remain as problem solving situations and not "obstacles" that prevent success.

Theme 2: Tool Use and Constraints

The survey was also designed to explore aspects of tool use as teams collaborated via distance. Survey items queried respondents about the types of collaborative technologies they were using, and which ones best facilitated their research collaboration via distance. The technological tool most used was e-mail, which was indicated as being used by 100% of those surveyed. E-mail was also consistently cited as a best facilitator of research collaboration via distance. One respondent stated, "E-mail has been used the most. Since we all monitor it nearly continuously, it has served us well in rectifying problems and difficulties." Another respondent added, "E-mail provides asynchronous message capabilities for reading at one's convenience."

Sixty-six percent of the respondents selected the telephone, a traditional tool. However, only 17% of those surveyed indicated teleconferencing, another traditional tool. One respondent even noted, "I do not like teleconferencing, as it requires all participants to be free at the same time."

Sixty-one percent of the participants specified that they use word processing editing tools. This tool was also well accepted as a best facilitator in the qualitative area of the survey. Several respondents noted the effectiveness of being able to see the suggestions and changes of other team members. However, it was cited that lack of skills

with these tools could also hinder the collaboration process. This is also true in the uses of Web sites, which were acknowledged by 56% of those surveyed.

Other tools were revealed to be used far less than those previously mentioned. Eleven percent of the survey participants indicated the use of each of the following in their collaborative endeavor: electronic mailing lists, instant messaging, and FTP. Digital imaging and streaming audio and video were not selected by any of the respondents. Discussion boards, for example, were only used by 22% of the respondents. However, while responses regarding use of this tool might be interpreted as minimal in terms of its use, it was reported to be a "best facilitator" when the tool simultaneously supported both teaching and research activities. According to one respondent, "the discussion board is being used by our students and is functioning as our main data source at this time."

Videoconferencing, a nontraditional tool, appeared on 17% of the surveys. This tool was also noted several times as a best facilitator of collaboration via a distance because it enabled unique types of social interaction between participants. For some respondents, collaboration is enhanced when participants are able to see and hear the nuances of interpersonal communication. One respondent commented, "I need facial expressions to see emotions that are tied to comments." The potential for videoconferencing, to enhance the collaborative work of teams, however, was perhaps undermined due to infrastructure limitations involving hardware, networking, and bandwidth capacity. As one respondent said, "Synchronous capabilities, such as video conferencing and instant messaging, may not be as quick as face-to-face conversation, due to limits of equipment, bandwidth, etc."

Uses of collaborative technologies in research collaborations via distance are influenced by a variety of needs and conditions. In some cases, technical infrastructure constrains the extent to which technologies are seen as resources that can usefully support collaborative relationships and the functional aspects of their work. Use of various technologies was also influenced by the extent to which they served multiple and/or highly unique purposes for the researchers.

Portraitures of Collaborative Work via Distance

Several survey items were designed to explore the nature of collaborative relationships via distance. One survey item prompted respondents to use a metaphor to describe their collaborative research experience via distance; this item was intended to solicit authentic referents that participants associated with their collaborative experience. Each respondent submitted a brief description to this survey item; however, few participants actually framed their experience in metaphorical terms. A majority of responses provided brief commentaries, such as "interesting and rewarding," "frustrating," "challenging," and "fine and helpful." Several participants conveyed *developmental* interpretations, in statements such as "evolving," "in the beginning stage," and "a work in progress." One respondent used a developmentally-oriented metaphor to describe the experience as "an infant growing rapidly." Another respondent similarly commented, "My experience has been meaningful and developmentally challenging. I have grown in knowledge and skills because of it, and some of the tasks I have engaged in could not have occurred without [the collaborative research experience via distance]."

Given the limitations of the data available, it is not possible to qualify responses as having positive or negative connotations. However, across these responses there is a sense that participants valued their *overall* research experience despite feelings of frustration and challenges. The developmental metaphors might be interpreted as portraitures of *individual* learners who accept that learning takes place over time. However, responses also suggest that time is viewed quite differently when it configures into the collaborative nature of group performance and production of research.

The survey also explored "timeliness of research" as an aspect of the collaborative experience via a distance. Twelve (66.7%) of the respondents replied that the "timeliness of their research" was enhanced by distance collaboration. In describing the enhancing nature of distance collaboration, one respondent said, "Such collaboration facilitates the abilities of researchers to manage time and distance obstacles." Another stated, "Distance collaboration allows for quick turn-around of drafts, ideas, etc." Four (22.2%) thought that it detracted from the timeliness of research. Two of these noted that conflicts with schedules and other tasks created difficulties in getting the information in a timely fashion. Another noted, "Any collaborative research is more time consuming than individual research." This final comment bears further consideration as collaboration requires time to be accepted as a *shared* rather than *individual* resource.

Discussion

The primary goal of this study was to examine the successes and barriers of the use of distance technologies for collaborative research. The results reveal that e-mail is the most preferred tool of collaborators conducting research via distance. This corresponds with the findings of Kalakota and Winston (1996) and Pauleen and Yoong (2001) in previous research in the area of e-mail usage in collaboration via distance. The qualitative data also supports this research through simple statements such as "e-mail has been used the most." Other observations of qualitative data such as "providing asynchronous message capabilities for reading at one's convenience" support the research of Kettinger and Grover (1997) in that e-mail enables the sender and recipient to control the timing of communication. The results of this study would also indicate that the asynchronous nature of e-mail is most important to teams collaborating via distance as was noted by DeSanctis et al. (2001).

The participants in this study are members of an organization that focuses on the research of online education (National Center for Online Learning Research, 2001). In analyzing the data, it is interesting to discover that technological skills are not perceived as the strongest aspect of the collaborative teams. In fact, the rating of this skill received the lowest average among all of the surveyed areas of strength. The lack of technological skills could possibly explain the fewer number of participants who had conducted collaborative research via distance previously (10) as opposed to those who had simply conducted collaborative research (18). Another possible area of consideration is that the participants entered into these collaborative partnerships to improve their technological skills. This descriptive statement made by one of the respondents, "I have grown in knowledge and skills because of [my collaborative experience]," can support this theory.

Yet other possible areas of consideration involving the weakness of technological skills from our participants can also be conceived by observing the two skills rated

highest, teaching and innovation. In analyzing teaching as a strength, it is conceivable that the participants are more content-oriented and less technology-oriented professors. However, participating in the NCOLR organization would indicate a desire to enhance one's technological skill level. This would also correlate with innovation also being perceived as a major strength of the collaborative teams. By indicating that they are innovative, the participants reveal a desire to experiment with new trends in education and research. Apparently, they do not perceive technology as a limitation or as something to fear. Instead, the participants view it as a new area to explore.

Regarding innovation, it is interesting to observe the low results in the use of the more modern tools of collaboration as opposed to those considered more traditional. Two of the newest tools of collaboration, digital imaging and streaming audio and video, were not indicated as being used at all by the participants. Other relatively new collaboration tools such as electronic mailing lists, instant messaging, FTP, and videoconferencing were also indicated as being used by few participants. These results, along with the qualitative data regarding the limitations of equipment and bandwidth, speak to the problem of possible lack of a quality technological infrastructure. This would directly correspond to the research of Pauleen and Yoong (2001) which states that the effectiveness and selection of communication technologies is strongly impacted by infrastructures. Another possibility is that the participants did not have an understanding of the newer communication tools, which was emphasized in the research of Mulder (2000).

The research of Teasley and Wolinsky (2001) indicates that the telephone, a traditional tool of communication, is still used for coordinating most collaborative research via a distance. This study reinforces their finding because two thirds of our participants indicated the use of the telephone for collaboration. Pauleen and Yoong (2001) describe the telephone as not having the label of new technology. The results of this study directly related to this because the participants in the study cited only average technological skills. Apparently, the participants were familiar and comfortable with this traditional method of communication and were not likely to observe it as a technological tool.

In analyzing the metaphorical data, the statement of one of the respondents describing the collaboration via a distance process as an infant growing rapidly is indicative of the growth of technology in the educational world of today. This corresponds to the research of Teasley and Wolinsky (2001), which states recent advances and improvements in computer and telecommunications technologies have optimized the conditions to support distance collaboration. All of which correspond to theoretical findings in this study. One assumption is that the collaboration via distance process is one with which the participant is comfortable, and it does not posses "the aura and baggage of a new technology" (Pauleen & Yoong, 2001, p. 196). Another assumption relates to the findings of Mulder (2000), which state that collaborators must have a shared understanding of the communication technologies. This would illustrate the reason that e-mail and telephone were considered the most effective.

Conclusion

This study found similar results as in other research on virtual teams, distance collaboration, and communication technologies. In order for collaborative research via a distance to progress and grow in effectiveness, perhaps institutions must support the continued modernization of technology infrastructures. These institutions should also support the increasing of technological skills by providing staff development, which ensures that their respective faculty members have the adequate training and knowledge to use distance communication tools effectively. This study has revealed what one group of researchers perceived as the most effective tools for collaboration via a distance. As technology and infrastructures continue to be enhanced, future research should focus on the increased effectiveness and use of the less traditional tools analyzed in this study.

Note

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References

Amber, V., & Thies, S. (2001). Digital cameras in education. *Society for Information Technology and Teacher Education International Conference, 1,* 1526-1528.

Barnes, S., & Greller, L. M. (1994). Computer-mediated communication in the organization. *Communication Education, 43*(2), 129-142.

Besser, H., & Yamashita, R. (Eds.). (1998). *The cost of digital image distribution: The social and economic implications of the production, distribution, and usage of image data.* Berkeley: University of California-Berkley, School of Information Management & Systems.

Brumbaugh, K., & Hart, N. (1993). ftp: The educator's key to multi-platform file transfers. *THE Journal*, *20*(10), 65-69.

Carmona, J. (1995). The Internet: Opening doors for education. *THE Journal*, *23*(1), 10-14.

Chidambaram, L. (1996). Relational development in computer supported groups. *Management Information Systems Quarterly, 20,* 142-165.

Clark, J. (2000, October) Collaboration tools in online learning environments. *Asynchronous Learning Networks Magazine, 4*(1), Article 2. Retrieved March 1, 2003 from http://www.aln.org/publications/magazine/v4n1/clark.asp

Cresswell, J. W. (2002). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research*. Upper Saddle River, NJ: Merrill Prentice Hall.

DeSanctis, G., Wright, M., & Jiang, L. (2001). Building a global learning community. *Communications of the ACM, 44*(12), 80-82.

Driscoll, M (1998) *Web-based training.* San Francisco: Jossey-Bass.
Electronic collaboration: A practical guide for educators. (1999). Providence, RI: Northeast and Islands Regional Educational Laboratory.
Evans, R. (1999). Serving modern students in a modern society at the community college. *THE Journal*, *27*(3), 102.
Guba, E. G., & Lincoln, Y. S. (1989). *Fourth generation evaluation*. Newbury Park, CA: Sage.
Hean, D. (1999). *Business collaboration over the web*. Paper presented at the 6th Annual New Zealand Engineering and Technology Postgraduate Student Conference, School of Engineering, University of Auckland, Auckland, New Zealand.
Kalakota, R., & Whinston, A. (1996). *Frontiers of electronic commerce*. Reading, MA: Addison-Wesley.
Kettinger, W. J., & Grover, V. (1997). The use of computer-mediated communication in an interorganizational context. *Decision Sciences*, *28*(3), 513-555.
Lau, F., Sarker, S., & Sahay, S. (2000). On managing virtual teams. *Healthcare Information Management Communications, 40*(2), 46-53.
Lipnack, J., & Stamps, J. (1997). *Virtual teams: Researching across, space, time, and organizations with technology*. New York: Wiley.
Loucks-Horsley, S. (Ed.). (1998). *Designing professional development for teachers of science and mathematics.* Thousand Oaks, CA: Corwin.
Mulder, I. (2002). A didactic model for learning and working together in global virtual teams. In Purdue, D. & Stewart, M. (Eds.), *Understanding collaboration* (pp. 159-162). Bristol, England: University of the West of England, Faculty of the Built Environment.
Murray, B. (1999). Schools unready for technology boom. *APA Monitor on Psychology, 30* (9), 22.
National Center for Online Learning Research. (2001). *Mission statement.* Retrieved March 1, 2003 from http://www.ncolr.org/ncolr/mission_statement.asp
Pallen, M. (1995). Guide to the Internet: Logging in, fetching files, reading news. *British Medical Journal, 311,* 1626-1630.
Pauleen, D., & Yoong, P. (2001). Facilitating virtual team relationships via Internet and conventional communication channels. *Internet research: Electronic networking applications and policies*, *11*(3), 190-202.
Perey, C. (1997). Desktop videoconferencing. In D. Coleman (Ed.), *Groupware: Collaborative strategies for corporate LANS and Intranets* (pp. 321-343). Upper Saddle River, NJ, Prentice Hall.
Rosch, W. (1995). Dropping a line in the data age. *PC/Computing, 8*(2), 238.
Schwartz, D. G. (1999). When e-mail meets organizational memories: Addressing threats to communication in a learning organization. *International Journal of Human-Computer Studies*, *51*, 599-614.
Sole, D. L., & Applegate, L. M. (2000). Knowledge sharing practices and technology use norms in dispersed development teams. In Ang, S., Krcmar, H., Orlikowski, W., Weill, P., & DeGross, J. (Eds.), *Proceedings of 21st International Conference on Information Systems* (pp. 581-587). Atlanta, GA: Association for Information Systems.

Tangney, B., Holmes, B., & Fitzgibbon, A. (2000). Teaching computers & society: The medium and the message. *International Conference on Mathematics/Science Education and Technology, 1*, 375-380.

Teasley, S., & Wolinsky, S. (2001). Scientific collaborations at a distance. *Science, 292,* 2254-2255.

Townsend, A., DeMarie, S., & Hendrickson, A. (1998, August). Virtual teams: Technology and the workplace of the future. *The Academy of Management Executive, 12*(3), 17.

Walther, J. B. (1997). Group and interpersonal effects in international computer-mediate collaboration. *Human Communications Research, 23*(3), 342-369.

Warkentin, M., Sayeed, L., & Hightower, R. (1997). Virtual teams versus face-to-face teams: An exploratory study of a web-based conference system. *Decision Sciences, 28*, 975-976.

Wasser, J. D., & Bresler, L. (1996). Working in the interpretive zone: Conceptualizing collaboration in qualitative research teams. *Educational Researcher, 25*(5), 5-15.

Wright, V., Stewart, J., Wright, K., & Barker, S. (2001). Techniques for sports medicine professionals via the Internet. *Sports Medicine Update, 15*(2), 35-37.

Zsiray, S., Jr., Smith, T., & West, R. (2001) Desktop videoconferencing. *THE Journal, 28*(8), 20.

Appendix A

Research Collaboration via Distance Online Survey
The purpose of this study is to examine the successes and barriers of the use of distance technologies for collaborative research encountered by members of the respective NCOLR research teams.

Position? ☐ Professor ☐ Associate Professor ☐ Assistant Professor ☐ Instructor ☐ Lecturer ☐ High School Teacher ☐ Other

Position Classification? ☐ Tenured ☐ Tenure-track ☐ Non-tenure track ☐ Other

Gender? ☐ Male ☐ Female

Age? ☐ 25-30 ☐ 31-40 ☐ 41-50 ☐ 51+

Have you participated in collaborative research previously? ☐ Yes ☐ No

Have you participated in collaborative research via distance previously? ☐ Yes ☐ No

What are the various tools that you are using to collaborate with research team members via distance? (You may choose more than one)

☐ E-mail
☐ Web sites
☐ Video Conferencing
☐ Streaming Audio/Video
☐ Discussion Boards
☐ Telephone
☐ Electronic Mailing Lists
☐ Teleconferencing
☐ Instant Messaging
☐ File Transfer Protocol (FTP)
☐ Digital Imaging
☐ Word Processing Editing Tools

Other ☐

Of the tools indicated above, are any a best facilitator of research collaboration via distance? (briefly describe why)

Do any technological tools hinder the process of research collaboration via distance? (briefly describe why)

What strengths do you bring to the research collaborative team?
Rate your contribution in the following areas, on a scale of 3=high; 2=medium; 1=low:

	3	2	1
Technology	☐	☐	☐
Research	☐	☐	☐
Teaching	☐	☐	☐
Scholarly Writing	☐	☐	☐
Innovation	☐	☐	☐
Task Management	☐	☐	☐
Data Analysis	☐	☐	☐

(Descriptively or metaphorically, please complete the following sentence.) Overall, I would describe my collaborative research via distance experience as…

Does research collaboration via distance enhance or detract from the timeliness of your research? ☐ Enhance ☐ Detract

Briefly explain your answer.

If you and your colleagues were collaborating in the same physical place, would your project be progressing the same or differently? ☐ Same ☐ Differently

Briefly explain your answer.

Please indicate any other comments regarding your experience in research.

Appendix B

Position?

Response	Num Responses	Raw %	Adjusted %	20 40 60 80
Professor	6	33.33	33.33	
Associate Professor	8	44.44	44.44	
Assistant Professor	4	22.22	22.22	
Instructor	0	0.00	0.00	
Lecturer	0	0.00	0.00	
High School Teacher	0	0.00	0.00	
Other	0	0.00	0.00	

Position Classification?

Response	Num Responses	Raw %	Adjusted %	20 40 60 80
Tenured	12	66.67	66.67	
Tenure-track	5	27.78	27.78	
Non-tenure track	1	5.56	5.56	
Other	0	0.00	0.00	

Gender?

Response	Num Responses	Raw %	Adjusted %	20 40 60 80
Male	6	33.33	33.33	
Female	12	66.67	66.67	

Age?

Response	Num Responses	Raw %	Adjusted %	20 40 60 80
25-30	0	0.00	0.00	
31-40	4	22.22	22.22	
41-50	8	44.44	44.44	
51+	6	33.33	33.33	

Have you participated in collaborative research previously?

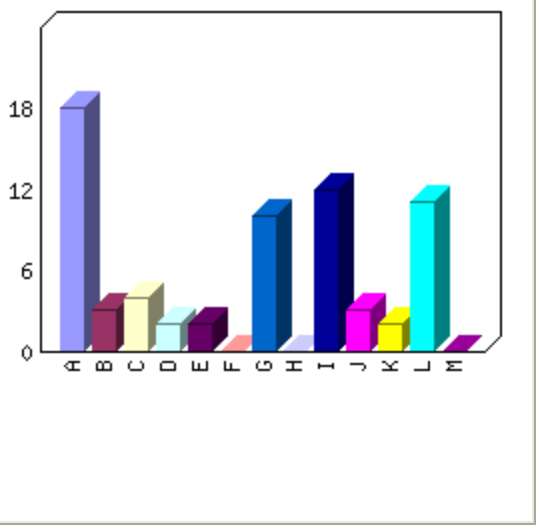
Response	Num Responses	Raw %	Adjusted %	20 40 60 80
Yes	16	88.89	88.89	
No	2	11.11	11.11	

Have you participated in collaborative research via distance previously?

Response	Num Responses	Raw %	Adjusted %	20 40 60 80
Yes	10	55.56	55.56	
No	8	44.44	44.44	

What are the various tools that you are using to collaborate with research team members via distance? (You may choose more than one)

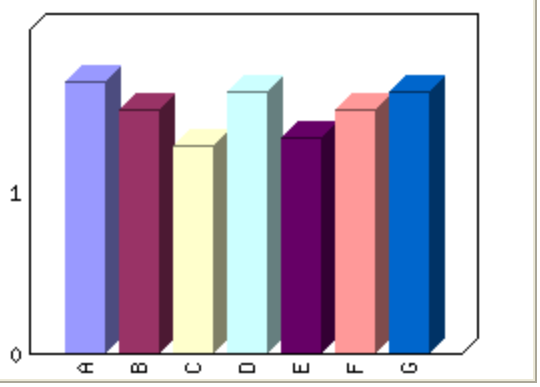
Response	Num Responses	Percent (%)	Color
E-mail	18	100.00	A
Video Conferencing	3	16.67	B
Discussion Boards	4	22.22	C
Electronic Mailing Lists	2	11.11	D
Instant Messaging	2	11.11	E
Digital Imaging	0	0.00	F
Web sites	10	55.56	G
Streaming Audio/Video	0	0.00	H
Telephone	12	66.67	I
Teleconferencing	3	16.67	J
File Transfer Protocol (FTP)	2	11.11	K
Word Processing Editing Tools	11	61.11	L
No Response	0	0.00	M



*Since this is a Many of Many, Totals may not add

What strengths do you bring to the research collaborative team?

Category	Num Responses	Mean Score	Color
Technology	18	1.67	A
Research	18	1.50	B
Teaching	18	1.28	C
Scholarly Writing	18	1.61	D
Innovation	18	1.33	E
Task Management	18	1.50	F
Data Analysis	18	1.61	G



Technology

Response	Num Responses	Raw %	Adjusted %	20 40 60 80
3	7	38.89	38.89	
2	10	55.56	55.56	
1	1	5.56	5.56	

Total Responses : 18 **Mean :** 1.67 **Median :** 2 **Variance :** 0.3529 **Std. Dev :** 0.5941

Research

Response	Num Responses	Raw %	Adjusted %	20 40 60 80
3	10	55.56	55.56	
2	7	38.89	38.89	
1	1	5.56	5.56	
No Response	0	0.00		

Total Responses : 18 **Mean :** 1.50 **Median :** 1 **Variance :** 0.3824 **Std. Dev :** 0.6183

Teaching

Response	Num Responses	Raw %	Adjusted %	20 40 60 80
3	14	77.78	77.78	
2	3	16.67	16.67	
1	1	5.56	5.56	
No Response	0	0.00		

Total Responses : 18 **Mean :** 1.28 **Median :** 1 **Variance :** 0.3301 **Std. Dev :** 0.5745

Scholarly Writing

Response	Num Responses	Raw %	Adjusted %	20 40 60 80
3	8	44.44	44.44	
2	9	50.00	50.00	
1	1	5.56	5.56	
No Response	0	0.00		

Total Responses : 18 **Mean :** 1.61 **Median :** 2 **Variance :** 0.3693 **Std. Dev :** 0.6077

Innovation

Response	Num Responses	Raw %	Adjusted %	20 40 60 80
3	12	66.67	66.67	
2	6	33.33	33.33	
1	0	0.00	0.00	
No Response	0	0.00		

Total Responses : 18 **Mean :** 1.33 **Median :** 1 **Variance :** 0.2353 **Std. Dev :** 0.4851

Task Management

Response	Num Responses	Raw %	Adjusted %	20 40 60 80
3	10	55.56	55.56	
2	7	38.89	38.89	
1	1	5.56	5.56	
No Response	0	0.00		

Total Responses : 18 **Mean :** 1.50 **Median :** 1 **Variance :** 0.3824 **Std. Dev :** 0.6183

Data Analysis

Response	Num Responses	Raw %	Adjusted %	20 40 60 80
3	8	44.44	44.44	
2	9	50.00	50.00	
1	1	5.56	5.56	
No Response	0	0.00		

Total Responses : 18 **Mean :** 1.61 **Median :** 2 **Variance :** 0.3693 **Std. Dev :** 0.6077

Does research collaboration via distance enhance or detract from the timeliness of your research?

Response	Num Responses	Raw %	Adjusted %	20 40 60 80
Enhance	12	66.67	75.00	
Detract	4	22.22	25.00	
No Response	2	11.11		